bart
impact
program

Land Use and Urban Development Project

STUDY OF DEVELOPMENT PATTERNS

working paper

The BART Impact Program is a comprehensive, policy-oriented study and evaluation of the impacts of the San Francisco Bay Area's new rapid transit system (BART).

The program is being conducted by the Metropolitan Transportation Commission, a nine-county regional agency established by state law in 1970.

The program is financed by the U. S. Department of Transportation, the U. S. Department of Housing and Urban Development, and the California Department of Transportation. Management of the Federally funded portion of the program is vested in the U. S. Department of Transportation.

The BART Impact Program covers the entire range of potential rapid transit impacts, including impacts on traffic flow, travel behavior, land use and urban development, the environment, the regional economy, social institutions and life styles, and public policy. The incidence of these impacts on population groups, local areas, and economic sectors will be measured and analyzed. Finally, the findings will be interpreted with regard to their implications for the planning of transportation and urban development in the Bay Area and other metropolitan areas.

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BART IMPACT PROGRAM

LAND USE AND URBAN DEVELOPMENT PROJECT

STUDY OF DEVELOPMENT PATTERNS

June 1978

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PREPARED FOR

U.S. DEPARTMENT OF TRANSPORTATION

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16. Abstract

This working paper examines BART's effects on Bay Area, corridor, and station area land use and development patterns. BART's effects on the supply and demand for housing, commercial, and institutional uses are evaluated, using a variety of analysis techniques. These include regional regression analysis of BART's influence on population, housing, and employment; statistical analyses of survey results; and key informant interviews. Particular emphasis is placed on effects on minorities. This paper also synthesizes earlier work elements of the BART Impact Program Land Use and Urban Development Project. Study conclusions are that BART has not affected regional development patterns, but has had effects on station area (mostly commercial and institutional) and corridor development patterns. These effects, however, have been less than the anticipated level of influence. The policy implications of these findings also are addressed.

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Metropolitan Transportation Commission

SAN FRANCISCO BAY REGION

CENTRAL AREA

BART: The Bay Area Rapid Transit System

Length: The 71-mile system includes 20 miles of subway, 24 miles on elevated structures and 27 miles at ground level. The subway sections are in San Francisco, Berkeley, downtown Oakland, the Berkeley Hills Tunnel and the Transbay Tube.

Stations: The 34 stations include 13 elevated, 14 subway and 7 at ground level. They are spaced at an average distance of 2.1 miles: stations in the downtowns are less than one-half mile apart, while those in suburban areas are two to four miles apart. Parking lots at 23 stations have a total of 20,200 spaces. There is a fee (25 cents) at only one of the parking lots. BART and local agencies provide bus service to all stations.

Trains: Trains are from 3 to 10 cars long. Each car is 70 feet long and has 72 seats. Top speed in normal operations is 70 mph with an average speed of 36 mph including station stops. All trains stop at all stations on the route.

Automation: Trains are automatically controlled by the central computer at BART headquarters. A train operator on board each train can override automatic controls in an emergency.

Magnetically encoded tickets with values up to $20 are issued by vending machines. Automated fare gates at each station compute the appropriate fare and deduct it from the ticket value. At least one agent is present at each station to assist patrons.

Fares: Fares range from 25 cents to $1.45, depending upon trip length. Discount fares are available to the physically handicapped, children 12 and under, and persons 65 and over.

Service: BART serves the counties of Alameda, Contra Costa and San Francisco, which have a combined population of 2.4 million. The system was opened in five stages, from September 1972 to September 1974. The last section to open was the Transbay Tube linking Oakland and the East Bay with San Francisco and the West Bay.

Routes are identified by the terminal stations: Daly City in the West Bay, Richmond, Concord and Fremont in the East Bay. Trains operate from 6:00 a.m. to midnight on weekdays, every 12 minutes during the daytime on three routes: Concord-Daly City, Fremont-Daly City, Richmond-Fremont. This results in 6-minute train frequencies in San Francisco, downtown Oakland and the Fremont line where routes converge. In the evening, trains are dispatched every 20 minutes on only the Richmond-Fremont and Concord-Daly City routes. Service is provided on Saturdays from 9 a.m. to midnight at 15-minutes intervals. Future service will include a Richmond-Daly City route and Sunday service. Trains will operate every six minutes on all routes during the peak periods of travel.

Patronage: Approximately 142,000 one-way trips are made each day. Approximately 200,000 daily one-way trips are anticipated under full service conditions.

Cost: BART construction and equipment cost $1.6 billion, financed primarily from local funds: $942 million from bonds being repaid by the property and sales taxes in three counties, $176 million from toll revenues of transbay bridges, $315 million from federal grants and $186 million from interest earnings and other sources.

March 1978

NOTICE

This document is disseminated under the sponsorship of the U.S. Department of Transportation and Department of Housing and Urban Development in the interest of information exchange. The United States Government and the Metropolitan Transportation Commission assume no liability for the contents or use of this document.

PREPARED BY JOHN BLAYNEY ASSOCIATES/DAVID M. DORNBUSCH & CO., INC.
A JOINT VENTURE

UNDER CONTRACT WITH THE METROPOLITAN TRANSPORTATION COMMISSION
FOR THE U.S. DEPARTMENT OF TRANSPORTATION
AND THE U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
UNDER CONTRACT DOT-OS-30176, TASK ORDER 205

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PREFACE

The BART Impact Program (BIP) is a comprehensive policy-oriented effort to identify, describe, measure, and present findings as accurately as possible about the multi-faceted impacts of a major public transportation investment — the BART system. The major objective of the Land Use and Urban Development Project is to determine how and to what extent BART has influenced the spatial arrangements of people and activities within the San Francisco Bay Area. To accomplish this task, the project will focus on the way BART has influenced (1) location decision processes; (2) actual movement behavior that results from those decisions and other market forces; and (3) the form, character, and functioning of aggregate spatial groupings that represent the net outcome of those decisions and movement patterns. Changes attributable to BART will be measured against pre-BART and no-BART alternatives. In all of these studies, BART's effects on individual socio-economic groups, particularly minorities and the disadvantaged, will receive careful attention.

The Land Use and Urban Development Project is one of six major projects comprising the BART Impact Program. The others are:

- Economics and Finance Project (E&F)
- Environmental Project (Env)
- Institutions and Lifestyle Project (ILS)
- Public Policy Project (PP)
- Transportation System and Travel Behavior Project (TSTB)

Each of these projects is designed to investigate specific aspects of BART's impacts, to explain why the impacts occur, and to identify who is affected by the impacts and the distributional effects. The projects then will demonstrate how the information derived can be used by decision-makers to enhance the benefits and to reduce the dis-benefits of BART, and to increase understanding of the potential impacts of rail transit investments in the Bay Area and other American metropolitan areas.

This working paper presents the analysis and findings of the study of BART's impacts on development patterns — one aspect of BART's land use impacts. The paper is presented for review by BART Impact Program staff, federal sponsors, and other interested planners and researchers. Comments on this paper as well as further analysis of BART's impacts will be incorporated in the final report.

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OBJECTIVES

The principal objectives for the study of development patterns are (1) to analyze BART's direct and indirect effects on development patterns, focusing on changes in the spatial distribution of population, employment, housing, and urban development; and (2) to determine whether minorities have been helped or hurt more than other socioeconomic groups living in the BART service area. A secondary objective has been to integrate the results of the Land Use Modeling (LUM) Project being conducted by the Metropolitan Transportation Commission (MTC) into the Land Use and Urban Development (LU & UD) Project. Using land use and urban development trends over the past 15-25 years as a point of reference, the magnitude, duration, and importance of BART's effects are examined at several scales of analysis, ranging from selected station areas, to corridor segments, cities, the BART service area, and the nine-county Bay Area.

This work element represents a "first cut" at synthesizing the diverse studies of BART's impact, incorporating results of the studies of the housing industry, the office construction industry, households', workers', and employers' location decisions, the study of retail sales, the 1977 MTC Workplace Survey, BART's consumption of land and property, BART's construction impacts, the study of property acquisition and occupancy (speculation), and MTC's LUM Project.

METHODOLOGY

Five research hypotheses were formulated, based on findings to date and prior expectations about BART's impact on development patterns. Some analysis techniques, such as the regression analyses of BART's impacts on development patterns, focused on the greater BART service area, using regional population, employment, housing, and land use files for 1970-1975 maintained by MTC. Further statistical tests were run on data from the 1977 MTC Workplace Survey and 1976 BART Passenger Profile Survey, both for area-wide and sub-area analyses. Further sub-area analyses also were conducted from surveys conducted for Work Elements 3 and 4 of the LU & UD Project of households moving to Walnut Creek and the Mission District and from East Oakland, and among workers in downtown San Francisco and Oakland.

Other techniques included analyses of land use changes between 1965 and 1977 around 18 BART stations, including 7 downtown stations, 7 urban stations, and 4 suburban stations. Special census data collected in Contra Costa County, Fremont, and Union City in 1974 and 1975 also provided valuable information, as did key informant interviews addressing the questions of BART's impacts on minorities. This paper builds on analyses and findings of previous work in

the BART Impact Program, particularly other elements of the LU & UD Project and the Economics and Finance, Environment, and Transportation Systems and Travel Behavior Projects.

FINDINGS

The conclusion of this study is that BART seems to have influenced the distribution of development within the BART corridors and in some station areas, but not to the degree anticipated by the system's planners. More specifically, evidence was found supporting the following findings:

- BART has not increased three-county BART service area growth at the expense of other Bay Area counties. Population and employment continue to grow at a faster rate in the rest of the region and, most specifically, in Santa Clara County. Population growth inside the service area was less than one percent between 1970 and 1975, while regional population outside the service area increased by nine percent.

- Within the four corridors served, BART has affected both employment and residential location decisions, but effects on employment location are more apparent. While not all development was BART-related, 51 percent of the employment increase in the 239 zone greater BART service area occurred in 31 zones surrounding 18 stations. In comparison, 14 percent of the growth in service area housing units was in these 31 zones.

- BART's effects within station areas have been greater on employment location decisions than residential location decisions. Little new housing has been built within 1,500 feet of BART stations, BART-related or otherwise, while there has been a significant amount of new office space specifically constructed to take advantage of proximity to BART.

- BART-related employment growth in station areas has been greater in the older central cities of San Francisco and Oakland (the centers) than in suburban areas such as Walnut Creek, Hayward, or Fremont (sub-centers). BART, along with other development incentives (zoning and public redevelopment), influenced the location of over three million square feet of new office space in San Francisco and Oakland, affecting job opportunities for over 12,000 persons. The only other major office buildings located in response to BART were in Richmond (400,000 square foot Social Security Administration Center), Berkeley (135,000 square foot Great Western building), and Walnut Creek (the 135,000 square foot Walnut Creek Plaza building).

- BART rarely influences a household's decision to move, but has affected the locational decisions of some service area households once the decision to move has been made. This primarily affects moves to or within suburban communities made by households with a member employed in downtown San Francisco or Oakland. BART has not markedly affected decisions to move from inner city areas to suburban communities. A small proportion of those influenced made such moves, and BART was no more important to these movers than it was to movers within suburban communities.

- In effects on the supply of housing, BART influenced the timing and location of several suburban multi-family projects in the Concord and Fremont corridors (i.e., such as the Diablo Keys complex in Walnut Creek), and a few scattered single family projects in outlying suburban areas, such as Fremont and the Pittsburg-Antioch area.

- Black suburban population growth is occurring in equal, if not greater, proportions than white growth in communities served primarily by the BART Richmond and Fremont lines. It is not clear whether BART is a more important factor in black suburbanization, but blacks do have a higher central city workplace orientation in Fremont — the one community where this was studied.

- BART has not significantly improved inner-city minority access to employment opportunities. BART does provide indirect benefits to central-city minority populations by being an influence on employers' decisions to stay in central-city locations rather than move to locations less accessible to minority populations.

BART's impacts on development patterns have been less than anticipated for several reasons. First, BART does not yet offer full, seven-day service, and has suffered from poor service quality and adverse publicity. Second, patronage has been substantially lower than projected; a daily BART patronage of 220,000 trips anticipated under full service conditions would have somewhat greater land use impacts. At current patronage levels, BART is used on less than three percent of all service area trips, and only about five percent of service area work trips. A longer period of service is necessary before definitive conclusions can be drawn. Finally, the low intensity commercial and residential districts adjacent to many suburban stations were not easily converted to the higher intensity clustering anticipated to form suburban sub-centers.

In many cases, local public policy did not reinforce or encourage BART impacts; some development opportunities were intentionally blocked, while others were not pursued aggressively. Fragmented local decision making perpetuates existing urbanization patterns and is not sensitive to the potential benefits of transit-oriented development.

In recent years, a depressed multi-family housing market has not provided much support for any high density station area housing proposals. The aggregate trend has been toward more single family dwellings built on vacant land, the locations of which BART could not greatly effect.

The development of large park-and-ride lots, as well as initial route and station location decisions that were not conducive to clustered development, contributed to the lack of land use changes in suburban areas. In several station areas with possible potential for private redevelopment, such as North Berkeley, Rockridge, and Orinda, zoning regulations were changed to restrict development or intense transit-oriented development never would have been permitted. At other stations around which high density development was permitted, market demand was

weak and little redevelopment occurred. Without higher density zoning bonuses near the stations, the costs of redevelopment in station areas exceed the costs of building on vacant land. While some households moving into Walnut Creek expressed a willingness to pay more for a site near BART, and developers expressed a willingness to pay an additional $500 to $5,000 a residential unit for land near BART stations, the differential cost of land acquisition and development has been greater than what the developers have been willing to pay, given the difficulties of land assembly and general station area environments.

In conclusion, these findings are not particularly surprising because of the relatively small impact BART has had on regional accessibility and mobility. It may be unreasonable to expect BART to have a greater impact on land use until competitive modes become more congested and BART is able to offer a significant savings in travel time and cost. Further, the limited opportunities for housing development in the BART service area provided a real constraint on BART's ability to affect land use and development decisions.

NO-BART ALTERNATIVE

In terms of the No-BART Alternative — the MTC-defined regional bus transit system that might have existed in the absence of BART (minor improvements to the 1971 transportation system) — BART's effects on development patterns have been greater for several reasons. First, BART was a visible public commitment to the central cities that encouraged employers to remain or locate in San Francisco, Oakland, and Richmond. To the extent that BART increases capacity in the Bay Bridge corridor more than the NBA, BART also will have a greater influence on downtown San Francisco employers' and workers' locational decisions. Third, BART provided a large portion of local credits for redevelopment projects in Oakland and Richmond, thereby expanding the City Center project and providing a site for the Social Security Administration in Richmond. Fourth, BART has had more effect than the NBA would on locational decisions of hedgers, those interested in the use of BART who do not use BART at present. Finally, BART amenities, such as plazas and direct entrances from offices and stores in San Francisco and Oakland, are unquantifiable factors that distinguish it from the NBA.

POLICY IMPLICATIONS

A better understanding of how BART, and possibly rail transit anywhere, affects development patterns can aid in formulating land use and urban development policy. However, it is important that the differences between the expectations and reality of BART's impacts be noted, and not just BART's effects vis-a-vis the No-BART Alternative.

A transit improvement such as BART will not particularly affect the rate of urban development within the service area. In the absence of strong economic demand in an area, a transit station will not cause development. A station may serve to shift the demands for office space or housing within a community and even a metropolitan area if those demands exist and incentives are offered for station area development.

BART will not change development patterns without accompanying and consistent policies from all levels of government. In order to have the effects anticipated, it would be necessary to institute much more supportive zoning and land use incentives and controls than has been the case in most communities served by BART. Density bonuses near stations, such as higher floor area ratios allowed near downtown San Francisco stations, or Fremont's minimum density residential zoning district adjoining the station, offer examples of necessary steps to encourage densities supportive of substantial pedestrian usage of stations.

Development is less attracted to sites near transit stations that primarily rely on park-and-ride patronage than it is to downtown station areas. Without coordinated and careful joint use planning, the size of the parking lots and traffic impacts create undesirable residential environments around park-and-ride stations. Successful joint use residential projects in station areas must consider noise and traffic impacts of the station, and be designed with these problems in mind.

Stations primarily devoted to park-and-ride patronage possibly should be located in undeveloped areas where large amounts of land could be assembled at costs lower than that associated with acquisition and relocation of existing uses in built-up suburban neighborhoods. This also would minimize adverse effects of any overflow parking and increased traffic on nearby neighborhoods.

Pedestrian stations located in urban central business districts will serve to reinforce these areas more effectively than park-and-ride stations will reinforce suburban areas. The highly visible public commitment to the central cities is important for encouraging private capital investment in these areas. The majority of new suburban development occurs on vacant land away from station areas, and suburban station area redevelopment awaits demand for intensification.

With current corridor land use policies BART will have more effect on employment location than housing, by allowing a greater flow of traffic through constrained corridors into employment centers, such as across the Bay into San Francisco and through the Caldecott Tunnel. With the large park-and-ride parking lots, suburban housing does not need to be near the station to be affected by BART, while office space at destination stations must be within walking distance as few persons are willing to transfer modes near their destination.

BART will not directly improve accessibility for minority populations in central cities to the degree it helps suburban commuters to central cities. Indirectly it will aid central city households to the degree that it encourages centralization

or slows the decentralization of employment, therefore maintaining employment in areas accessible by inner-city minority populations. Suburban employment locations are too decentralized to be served effectively by BART.

The limited land use impacts experienced in the Bay Area so far suggest that the case for rail rapid transit based on its urban form-making potential cannot be made easily. Planners and decision makers contemplating similar fixed rail rapid transit investments would be well-advised to re-evaluate their expectations for short-term transit-induced changes in light of the findings of this project. The passage of time and improvements in service quality may bring more dramatic land use impacts. Study of future effects should be pursued with a long-term monitoring project.

1. INTRODUCTION

Major transportation improvements will influence decisions on where to live and work if they significantly affect commuting times and costs. Over time, this impact on location decisions will be reflected in land use and development patterns. The issue to be addressed in this paper is whether and to what extent BART, the first regional rapid transit system to be built in the U.S. in 50 years, has affected Bay Area development patterns. Has BART changed the patterns of urbanization in the Bay Area? If not, will it in the future, or why not?

The principal objectives for this work element are (1) to analyze BART's direct and indirect effects on development patterns, focusing on changes in the spatial distribution of population, employment, housing, and urban development; and (2) to determine whether minorities have been helped or hurt more than other socioeconomic groups living in the BART service area. Because the study of development patterns has much in common with the Land Use Modeling (LUM) Project being conducted by MTC, a secondary objective was to integrate the LUM Project's findings into the LU&UD Project. Using land use and urban development trends in the Bay Area over the past 15-25 years as a point of reference, the magnitude, duration, and importance of BART's effects are examined at several scales of analysis, ranging from selected station areas to corridor segments, cities, the BART service area, and the nine-county Bay Area.

This work element builds on the results of studies of the housing industry, the office construction industry, retail sales, residents' and workers' location decisions, employers' location decisions, the 1977 Workplace Survey, BART's consumption of land and property, BART's construction impacts, property acquisition and occupancy around BART stations, and MTC's LUM Project. It represents a "first cut" at synthesizing the diverse studies of BART's impacts that will be necessary during preparation of the final report. Accordingly, many of the questions that will be addressed at this point in the project will be designed to clarify results of earlier studies through refined analyses.

In the study design four research hypotheses and 10 general questions were posed.[1] Further thinking about ways of investigating BART's impacts and the LUM Project's Phase I conclusion suggested several refinements to original research questions. These are discussed in Chapter 2, which reviews the research questions and study design. Chapter 3 presents an overview of Bay Area development trends over the past 20 years, and following in Chapter 4 are the hypotheses and conclusions.

1. John Blayney Associates/David M. Dornbusch & Co., Inc., Study Design and Project Implementation Plan (Berkeley: BART Impact Program Land Use and Urban Development Project Planning Document), March 1977.

2. RESEARCH QUESTIONS AND STUDY DESIGN

THEORETICAL PERSPECTIVE

Empirical and theoretical models of residential location, employment location, and the interactions between them have been formulated by many researchers in urban economics and geography. The basic theory of residential location, as developed by Alonso, Kain, Brown, and others (see Bibliography) posits a tradeoff between housing costs and journey to work costs, which includes the value of travel time as well as out-of-pocket costs. As a consequence, land rent declines with distance from the central business district (CBD). The effect of a transportation improvement (such as BART) is to lower transportation costs for a service area, thus encouraging consumption of more land and housing further from the CBD. On the other hand, if the improvement only affects one corridor, residential land prices and density will increase relative to other corridors.

Theories of employment location, such as central place models by Christaller, Berry, and Garrison suggest that a reduced transportation cost for a specific employment center will tend to increase production or employment at that point.

Interaction models, including gravity models (Lowry, for example), attempt to deal with the relationship of workplace and residence location without assuming fixed central locations for all employment as do the residential models, or fixed residential locations as do the employment location models. The interaction models approximate actual development closest by allocating exogenously determined basic or export-based jobs to zones, and then allocating residential development (based on assumptions of minimum commute time) by a gravity model which also assigns population-serving or non-basic employment as a proportion of the first-round residential allocations, subject, of course, to land availability. The third or latest generation models have incorporated travel mode choice into the allocation algorithm.

While there are several problems in attempting to apply any of the urban theoretical models to an understanding of BART's possible effects on development patterns, they were important in early expectations of BART's effects. Thus, the 1962 Composite Report expectations that BART would "maintain and encourage profitable concentrations of business and industry" and "preserve and increase property values in the central cities, regional subcenters and outlying areas" were based on such urban theory.[2]

2. Parsons, Brinckerhoff, Tudor, Bechtel, Composite Report - Bay Area Rapid Transit (May 1962), p. 76.

There appear to be several reasons why BART's impacts on development patterns do not seem to fit theoretical expectations, and these may be more related to problems with the models rather than characteristics of BART. Transportation models tend to ignore other strong influences on development besides economic theory, including the governmental intervention effects on the urbanization process. Local land use and zoning controls and environmental review procedures in the Bay Area have increased greatly since the 1950s and early 1960s when BART projections were made and today are major determinants of urban development. Other non-transportation determinants of land use include federal tax policy, ethnic discrimination, differing levels of public services in various communities, and Bay Area topographical constraints. Neighborhood and community political influence on decision makers also has become more important over the past 10-15 years, and the sum of these factors diminish the ability of such theoretical models to project land use changes correctly.

Even considering the non-transportation effects on land use, it is very difficult to predict the net effect of a change in commuting costs to a particular employment location with the theoretical models. The problem in determining the net effect of a commute time and cost change on density is that the effects on central area workers' residential locations and on population serving employment that follows those residents conflicts with the effect on central area employment. For example, while a commuting cost reduction tends to decrease density because workers consume more land and housing farther away and population serving employment will also decentralize to follow the residents, the same cost reduction tends to raise employment concentrations at the center and, therefore, the number of workers who must live within commuting range. Another problem with use of theoretical models for assessing the effects of BART is that models are generally not dynamic. Real estate investments are relatively long-term fixed assets, and therefore changes in patterns take many years to develop.

Rather than attempt a global model, a series of short, specific models were used in the regression analyses of BART's influence on changes in housing, population, and employment. A complete model explanation of these trends was not sought, but rather a preliminary exploration was conducted of BART's potential influence and other influences which may be related to the BART influence. This analytical approach was judged the most effective means of examining BART's effects on development patterns.

The hypotheses of this paper (see the following section) deal with BART's role in the various elements of the urbanization process. Hypothesis 1 deals with BART's role in the demand for housing in outlying areas, while Hypothesis 3 deals with the supply of housing. Hypothesis 2 is concerned with BART's possible centralization effects on employment, and Hypothesis 4 deals with BART's overall regional distributional effects. Hypothesis 5 specifically analyzes BART's effects on minority employment opportunities.

RESEARCH HYPOTHESES

Four research hypotheses about BART's effects on development patterns were originally formulated for testing in Work Element 7. These were restructured into five hypotheses, and each was restated into a series of sub-hypotheses in order to facilitate statistical testing and analysis.[3] The modified hypotheses are as follows:

HYPOTHESIS 1: BART has reinforced existing resident population movement trends, in particular increasing migration to outlying areas where new housing is available within acceptable commute distance.

1-A. Areas with the greatest accessibility improvement and closest to BART stations were also the areas with the largest increase in population.

1-B. Suburban residents who moved from inner or central cities are more likely to view BART as important than suburban residents who have moved from other areas.

1-C. Since BART began service there has been an increase in the proportion of commuters to central cities from suburban communities served by BART.

1-D. In selecting a residence location, white households that move are motivated more by BART than minority households.

HYPOTHESIS 2: BART has reinforced existing trends toward centralization of regional office employment in San Francisco.

2-A. Employment opportunities in the BART service area have increased in relation to distance to BART stations and accessibility gains with BART.

2-B. Employment opportunities have expanded more in San Francisco than elsewhere in the region as a result of BART.

HYPOTHESIS 3: BART has induced an increase in the supply of housing in outlying areas.

3-A. Housing built because of BART has been in outlying areas, while housing removed by BART construction was primarily in older, close-in areas.

3. Questions of minority employment impact were separated out into a fifth hypothesis. In other cases, main hypotheses were simplified, but all issues raised in the original hypotheses were covered within the sub-hypotheses.

3-B. Residential development in the BART service area was related to anticipated gains in accessibility by BART to jobs, as well as the supply of developable land and highway improvements.

3-C. Land developed as a result of BART was "next in line for development" in any case, and BART did not cause urban sprawl.

3-D. Increased employment outside the BART service area was also a major influence on residential development trends in the BART corridors.

3-E. BART, by stimulating construction in outlying areas, has had the effect of decreasing demand for inner city housing, increasing minority migration to the Bay Area and/or allowing minority households to occupy better housing than previously available.

3-F. BART-induced down-zoning rather than lack of demand has been the principal deterrent to inner city station area redevelopment.

HYPOTHESIS 4: BART's effects on regional land use patterns are negligible, but local and corridor effects have occurred.

4-A. BART has had little regional effect on Bay Area land use patterns.

4-B. BART's localized effects on commercial and institutional uses have been greater than its effects on residential densities and location.

4-C. BART has influenced development on prime agricultural land, environmentally sensitive land, and on seismically unsafe land.

4-D. Redevelopment projects expanded as a result of BART have had an adverse effect on minority housing and employment opportunities.

HYPOTHESIS 5: BART-induced development and BART service have expanded employment opportunities for minorities.

5-A. Public transit generally, and BART specifically, are more important criteria for accepting a job for minorities than non-minorities.

5-B. BART is having an effect on minority reverse commuting to employment opportunities.

5-C. Although work trips from central city minority areas are not well served by BART, BART has had significant indirect effects on minority employment opportunities.

METHODOLOGY

A variety of analyses techniques were used to test the validity of the hypotheses. These techniques included analyses of overall regional and corridor data, as well as data collected for particular study areas, including cities, zones adjoining selected stations, and areas within 1,500 feet of stations. This use of macro- and micro- scale data allowed examination of both regional and localized effects of BART.

Population, housing, employment, and land use data for 1970 and 1975 from the MTC-ABAG QUEST file created and calibrated for the Projective Land Use Model (PLUM) were used for regression analyses of the relationship between development patterns and BART accessibility improvements.

The multiple regression equation shows the relationship between a dependent variable and two or more independent variables. The general model takes the form:

$$Y = A + B_1X_1 + B_2X_2 + \ldots B_nX_n$$

where Y is the dependent variable and the Xs are the independent, predictor variables. Using empirical data, A and B_1, $B_2 \ldots B_n$, the constant and coefficients of the predictive relationship, are estimated.

The regression procedures used in the Statistical Package for the Social Sciences (SPSS) were employed in this analysis. The regression formulation was used to determine what effect BART, along with other factors, had on urban development within the service area during the 1970-75 time period. The advantage of the multivariate technique is that one can examine the separate, but interactive, effects of factors influencing development, and is not constrained to examining each effect separately. The goal of the regression analysis was not to formulate a complete model explaining changes in population, housing, and employment, but rather just to include those variables judged most important -- those variables related to BART's influence and those for which data were readily available.

It was postulated that population and housing growth could be "explained" by a number of factors, including the availability of land for housing, the distance from the closest central business district, and measures of accessibility to workplace by highway, bus, and BART. Rather than use a one-to-many accessibility index, a weighted measure of accessibility (mobility) for auto and bus to downtown San Francisco was used, weighting travel time by the number of actual trips by auto or bus.[4] For BART accessibility, the distance to the closest BART

4. This was not ideal, but is a more accurate measure than the one-to-many accessibility index. For further details on accessibility measures, see John Blayney Associates/David M. Dornbusch & Co., Inc., Accessibility Mapping, (Berkeley: BART Impact Program Land Use and Urban Development Project Working Paper, September 1977), pp. 5 and 6.

station was weighted by the 1976 AM peak hour BART patronage from that station. This reflects not only distance, but the revealed preferences of commuters. The resulting model was a gravity type (using the inverse of the distance to the CBD and to the nearest BART station) that measures the attractiveness of a trip based on distance. [5] By measuring distance to the nearest CBD, the model does not assume a monocentric employment location.

For the employment model, the same set of variables was used, with the BART PM, not AM, peak hour patronage used for weighting purposes in calculating the BART influence variable. Existing CBDs and the San Francisco mobility measures (accessibility to other employment) were expected to be key influences of employment in the BART service area. The resulting equations and variable definitions are as follows:

Population and Housing Equations

CRESP
PCRESP
CERES
PCERES = $A + B_1(ACCBHW) + B_2(ACCNTW) + B_3(DZBR) + B_4(RDL70) + B_5(CBDI)$
CODWU
PCODWU

The terms on the left represent the dependent variables; the terms on the right the independent variables, and the B_x represents the coefficients and "A" is the constant.

Employment Equations

CRETT
PCRETT
CRETS
PCRETS
CBUSS
PCBUSS = $A + B_1(ACCBHW) + B_2(ACCNTW) + B_3(DZBE) + B_4(RDL70) + B_5(CBDI)$
CFSGT
PCFSGT
CFIBI
PCFIBI

VARIABLE DEFINITIONS

Independent Variables

The following are the empirically available indicators that were used as the independent variables. The theoretical measure represented by the indicator is shown in parentheses.

5. For another modelling approach, see the BART Land Use Model (LUM) Project Stage II report by Nathaniel Lichfield and Partners, where before-after analysis of a stratified group (downtown-urban-suburban) of station area zones is presented.

- ACCBHW — Highway travel time from zone to downtown San Francisco weighted by 1976 peak hour highway trips (measure of highway influence)

- ACCNTW — Transit travel time from zone to downtown San Francisco weighted by 1976 peak hour transit trips other than BART (measure of other transit influence)

- DZBR — Inverse of distance to BART station weighted by 1976 AM peak station entrances (measure of BART residential influence)

- DZBE — Inverse of distance to BART station weighted by 1976 PM peak station entrances (measure of BART employment influence)

- RDL 70 — Proportion of developable land that was developed in 1970 (an inverse measure of opportunity for development or available supply of land).

- CBDI -- Inverse of distance to closest central business district (CBD), including San Francisco, Oakland, and several smaller CBDs — Fremont, Hayward, Richmond, and Walnut Creek.

Dependent Variables

- CRESP -- Change and percentage change in zone residential population, 1970-1975.

- CERES and PCERES -- Change and percentage change in zone employed residents, 1970-1975.

- CRETT and PCRETT -- Change and percentage change in zone retail trade employment, 1970-1975.

- CRETS and PCRETS -- Change and percentage change in zone retail service employment, 1970-1975.

- CBUSS and PCBUSS -- Change and percentage change in zone professional and business service employment, 1970-1975.

- CFSGT and PCFSGT -- Change and percentage change in zone federal and state government employment, 1970-1975.

- CFIBI and PCFIBI -- Change and percentage change in zone other services (finance, insurance, basic business services, and institutional services) employment, 1970-1975.

- CODWU and PCODWU -- Change and percentage change in zone occupied dwelling units, 1970-1975. (In the absence of any large shifts in vacancy rates in Bay Area housing, the change in occupied dwelling units was assumed to represent new construction and conversions to multiples minus demolitions and conversions to fewer units.)

Total employment was not used as a variable, but only those employment categories that were expected to be influenced by BART. None of the employment categories available from the PLUM data base were completely consistent with the goal of using only employment categories likely to be influenced by BART. For example, retail trade employment included food stores and auto dealers, two categories that would not be expected to be BART related, while the finance-insurance category did not include the banking industry. Equations were run on both absolute and percentage change models, in order to pick up both large magnitude growth areas (such as San Francisco employment) and areas of recent and dramatic growth trends (development from a small base).

For the regression analyses, a 239 traffic zone data base was used to represent the greater BART service area defined by the TSTB Project and comprised of the three BART Counties of Alameda, Contra Costa, and San Francisco, as well as the northern part of San Mateo County (Figure 1 illustrates the BART service area).[6] This area currently accounts for the origins of 96 percent of all BART riders.

Survey data collected by other projects and tasks in the BART Impact Program was also statistically analyzed. This included the following surveys:

Metropolitan Transportation Commission Workplace Survey -- This was conducted in 1977 among workers employed within a set of 88 traffic analysis zones (2-4 census tracts in size) readily accessible by BART. The survey had 8,391 responses, an approximately 1 in 60 sampling of the workers in the area surveyed, and focused on mode choice, travel time, work and residence location, and demographic characteristics.[7]

1976 BART Passenger Profile Survey -- This sampled 8,985 BART riders, focusing mainly on transportation questions and the socioeconomic characteristics of patrons.

Household Survey -- A study of 315 households and their reasons for moves into Walnut Creek, into the Mission District, and out of East Oakland (see the Study of Households' Location Decisions).[8]

6. See Peat, Marwick, Mitchell and Co., Demography of Areas Served by BART (Berkeley: BART Impact Program TSTB Project Working Note, October 1977).

7. See Peat, Marwick, Mitchell and Co., Analysis of 1977 Workplace Survey (Berkeley: BART Impact Program TSTB Project Working Note, December 1977).

8. See John Blayney Associates/David M. Dornbusch & Co., Inc., Households' Location Decisions (Berkeley: BART Impact Program Land Use and Urban Development Project Working Paper, February 1978).

Downtown Workers Survey — A study of 314 workers who had switched or started work in downtown San Francisco or Oakland during the past three years (see the Study of Workers' Location Decisions).[9]

Analyses of survey results were conducted for entire survey populations and selected sub-areas. For example, for some analyses of suburban characteristics, tabulations were done just for respondents to the Workplace Survey who lived in Orinda-Lafayette, Walnut Creek-Concord, Antioch-Pittsburg, Fremont-Union City, Pinole-El Sobrante, or Daly City-Pacifica, selected as representing those areas where movers were most likely to have been affected by BART. (These areas also are illustrated in Figure 1.)

Station area land use changes between 1965 and 1977 were studied for 18 stations, correlating the land use changes with the BART impacts found in the studies of the housing and office construction industries, employers' location decisions, and retail sales and services. Station areas analyzed included:

- Downtown station areas
  - Embarcadero (San Francisco)
  - Montgomery Street (San Francisco)
  - Powell Street (San Francisco)
  - Civic Center (San Francisco)
  - Lake Merritt (Oakland)
  - 12th Street (Oakland)
  - 19th Street (Oakland)

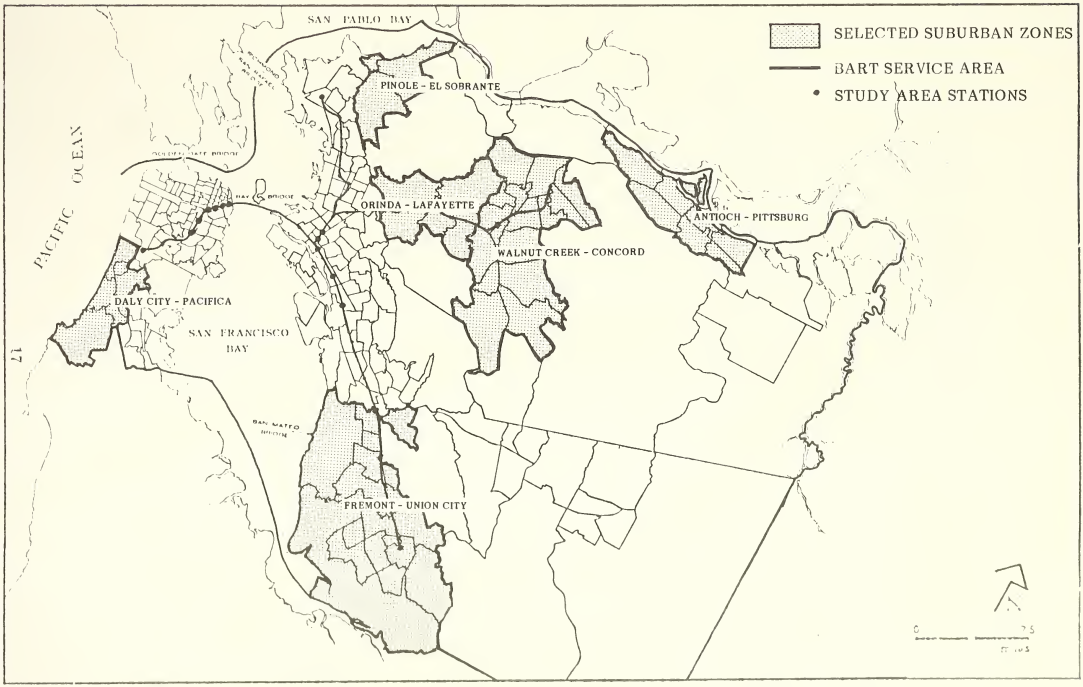
- Urban mixed-use station areas
  - Richmond
  - Fruitvale (Oakland)
  - Coliseum (Oakland)
  - Hayward
  - 16th Street-Mission (San Francisco)
  - 24th Street-Mission (San Francisco)
  - Daly City

- Suburban station areas
  - Walnut Creek
  - South Hayward
  - Union City
  - Fremont

These station areas encompassed most development around BART stations (see Figure 1 for stations).

9. See John Blayney Associates/David M. Dornbusch & Co., Inc., Workers' Location Decisions (Berkeley: BART Impact Program Land Use and Urban Development Project Working Paper, March 1978).

FIGURE 1. GREATER BART SERVICE AREA AND SELECTED SUBURBAN ZONES



Additional key informant interviews were conducted in the area of minority employment and housing impacts, but otherwise analysis of key informant interviews was limited to those conducted earlier in the Land Use and Urban Development Project, as well as from the Economics and Finance Project. Data collected by the Environment and the Transportation System and Travel Behavior Projects also were used in this study.

LIMITATIONS

The results and conclusions of this study cannot be considered the final word on BART impacts on Bay Area, corridor, and station area development patterns. It is still early in the service life of BART, and in fact, full seven-day service has yet to begin. It is anticipated that many years are necessary before final conclusions can be drawn.

Other limitations include the assumptions of universality of findings that were based on analysis of selected areas. Time and cost considerations did not allow in-depth analysis of all potentially related development, and therefore a sample of study areas was selected. The sample was selected to include a mix of different station area types, but also incorporated those stations where the majority of development has occurred. Finally, techniques used for analysis all have limitations. Key informants cannot always articulate BART's importance or recognize BART's effects. Many decisions, particularly in real estate, build on earlier ones by other individuals, and it is not always possible to identify the key decision points and individuals.

Limitations of the regression analysis included the availability of data from only one period of time, 1970-75, for a small number of measures.

Survey instruments provided valuable information, but all had their limitations. As is indicated, each was based on different sub-samples of Bay Area population, and each was designed to answer specific questions.

Metropolitan Transportation Commission Workplace Survey -- This survey has a large sample size (8,391 responses); however, the sampling was limited to those workers employed within a set of 88 traffic zones readily accessible by BART. Thus, respondents do not represent a cross-section of all work trips in the Bay Area, but rather only work trips to zones well-served by BART.

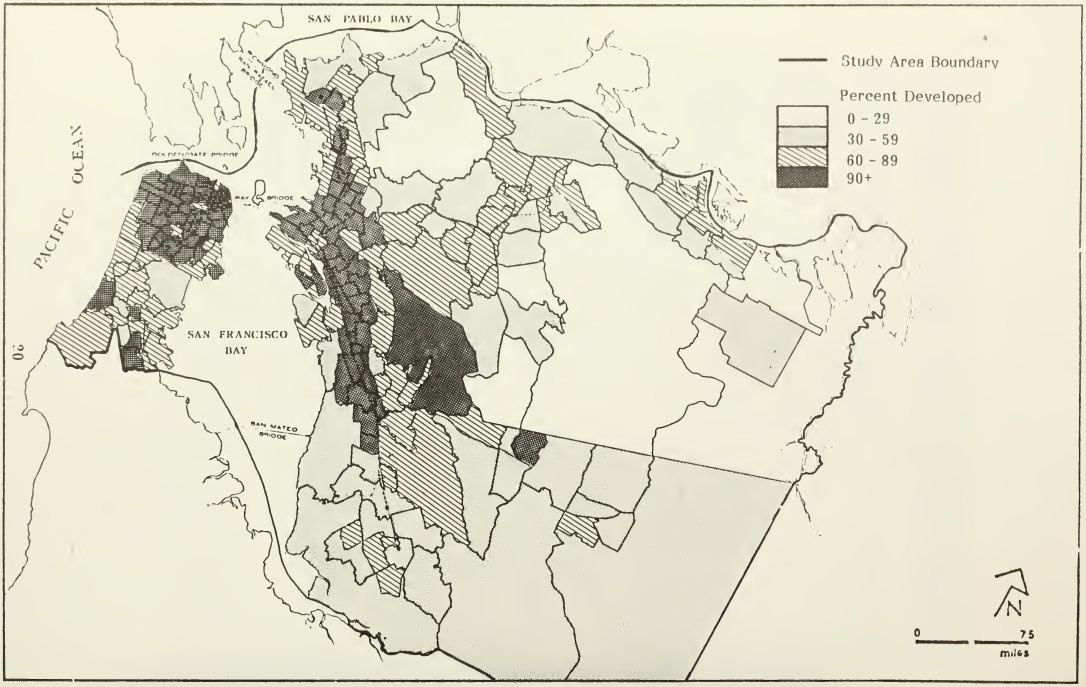
1976 BART Passenger Profile Survey -- This survey of 8,985 BART riders sampled a minimum number from each origin station. Thus, the survey provides valid information on trip or user characteristics for a specific station, but the sum total of survey responses are not exactly proportional to actual station patronage. Some stations are overrepresented; others are underrepresented.

Household Survey — This was a survey of whether BART influenced 315 households who had moved into Walnut Creek, into the Mission District, or out of East Oakland during the past two years, and the results may not represent the characteristics of all Bay Area movers.

Downtown Workers Survey — This survey sampled 314 workers who had switched jobs or started work in the past three years in either downtown San Francisco, downtown Oakland, or in an Oakland industrial area. This survey was limited basically to recent job changers who worked in several specific work locations. It also was stratified so that 50 percent of the respondents were BART riders. As was the case with the Household Survey, the size of the sample limited statistical analysis that could be conducted with this survey.

A 95 percent confidence level was set by the Land Use and Urban Development Project as the criterion for hypothesis testing. This is a rigorous level which suggests one was unlikely to accept a hypothesis of a BART impact when there was none. However, this increases the probability that there may have been some small BART impacts which could not be identified statistically.

FIGURE 2. DEVELOPED LAND AS A PERCENTAGE OF DEVELOPABLE LAND, 1970



Source: Association of Bay Area Governments–Metropolitan Transportation Commission QUEST File

3. FRAMEWORK FOR ANALYSIS

Before analyzing BART's effects on recent Bay Area development trends, it is useful to set the context of growth and urbanization into which BART was introduced. As the following section will indicate, the Bay Area has had and should continue to have significant growth in population, households and housing units, and employment. This growth, however, has not been consistent throughout the Bay Area, and has varied over time. Recent growth has been concentrated in Santa Clara County, Southern Alameda County, and central Contra Costa County. Finally, the rate of growth in population and households has diminished during the 1970s, the decade in which BART service began.

The implication of the trends in Bay Area growth is that few opportunities for residential development existed in the three-county BART service area between 1970 and 1975, with the exception being the Contra Costa corridor and Fremont-Union City. Thus, BART was rather limited in the effects on development patterns that it could have. In trend analysis, the above areas were studied most closely for effects on residential development, and these areas and the central cities for employment effects.

LAND CONSUMPTION

Land use patterns in the San Francisco Bay Area reflect the presence of natural barriers; namely, the Bay and the coastal hills. North-south corridors of development occur along both sides of the Bay, and an east-west corridor extends from the Berkeley Hills through central Contra Costa County to Walnut Creek and Concord where it intersects a corridor in the San Ramon Valley west of Mt. Diablo. Within the nine-county region, approximately 1350 square miles of land can accommodate urban development. By 1975, 51 percent of this land was developed for urban uses (Table 1). San Francisco County has been "built out" since the 1960s, while Alameda County had over two-thirds of its usable land developed in 1975, and Contra Costa County was approximately one-half urbanized by 1975. Between 1970 and 1975, approximately 6,000 acres in Contra Costa and 5,000 acres in Alameda became urbanized.

BAY AREA GROWTH

San Francisco Bay Area population growth has been a continuing phenomenon since World War II. Prior to 1950, most of the region's population growth occurred in San Francisco. Since that time (as is illustrated in Table 2), major Bay Area growth has been concentrated in Contra Costa County and in the southern portion of the Bay Area; Santa Clara, San Mateo, and southern Alameda counties. This reflects the growth of suburban employment centers in the South Bay as well as the growing suburbanization spurred on by rising standards of living. Marin and Sonoma counties have also had significant growth.

TABLE 1. THREE COUNTY AND BAY AREA (NINE-COUNTY) URBANIZED AREA,[a] 1970, 1975 AND 1990 PROJECTION

	Thousands of Acres				Percent of Area Urbanized	
Area	1970	1975	1990	Percent Change 1975-90	1975	1990
Alameda County	85	90	113	26	71	89
Contra Costa County	62	68	112-133	65-96	48	78-93
San Francisco County	24	24	24	0	96	96
Bay Area (9-County)	418	447	696-796	56-78	51	80-91

[a]Urbanized land includes residential, local serving, basic, and street and highway uses.

Source: Association of Bay Area Governments (ABAG), Provisional Series 3 Projections (Berkeley, California, March 1977).

Approximately 4.8 million people lived in the Bay Area in 1975, an increase from 4.6 million in 1970, 3.6 million in 1960, and 2.7 million in 1950. While the annual growth rate declined from 3.5 percent during the 1950-60 period to 2.7 percent from 1960 to 1970, the magnitude of growth was quite similar. Since 1970 both the percentage and magnitude of growth in population have declined significantly.

Population growth in the BART service area has been less than that outside the service area. Between 1970 and 1975 population growth in the BART service area was less than .1 percent annually compared to .35 percent in the BART corridors (those traffic zones immediately adjacent to BART lines), and 1.8 percent annually for the rest of the Bay Area, an understandable difference since the BART service area had been developed much earlier and little vacant land remained in 1970.[10]

Since 1970, household size has been decreasing quite dramatically, and this somewhat diminishes the value of population statistics in analysis of current development patterns. As land consumption, trip generation, and the size of the labor force are related as much if not more to households than they are to population, information on trends in household formation is essential for an understanding of Bay Area development trends. Thus, while San Francisco

10. It should be remembered that route location decisions for BART were made in the 1950s and the system was designed to link existing centers.

TABLE 2. POPULATION TRENDS IN THE SAN FRANCISCO BAY AREA, 1950-1975

County	U.S. Census 1950	U.S. Census 1960	U.S. Census 1970	Estimate 1975
Alameda	740,315	980,209	1,073,184	1,089,931
Contra Costa	298,984	409,030	558,389	582,842
Marin	85,619	146,820	206,038	216,059
Napa	46,603	65,890	79,140	89,976
San Francisco	775,357	740,316	715,674	672,648
San Mateo	235,659	444,387	556,234	576,358
Santa Clara	290,547	642,315	1,064,714	1,169,719
Solano	104,833	134,597	169,941	186,260
Sonoma	103,405	147,375	204,885	245,357
Total Region	2,681,322	3,710,939	4,628,199	4,829,150
Special Areas				
BART Service Area	1,814,656	2,188,700	2,525,991	2,536,156
BART Corridor	N/A	1,135,860	1,257,926	1,280,444
Rest of Region	866,666	1,450,328	2,102,209	2,292,994

Source: U.S. Census; 1975 Estimate, Association of Bay Area Governments.

population declined by 6 percent between 1970 and 1975, the number of households increased by 1.4 percent.[11]

Tables 3 and 4 give the populations and number of households for the BART service area counties and Bay Area total for 1970, 1975, and a 1990 projection. As can be seen, the number of households has increased and is expected to continue to increase at a faster rate than population. Using the household data it is obvious that growth outside the BART service area has been greater than growth inside, with the exception of Contra Costa County. BART, being limited to the service area in its effect, has had limited opportunities to shape new growth that has and will occur in the Bay Area.

TABLE 3. THREE COUNTY AND BAY AREA (NINE-COUNTY) POPULATION, 1970, 1975, AND 1990 PROJECTION
(Thousands of Persons)

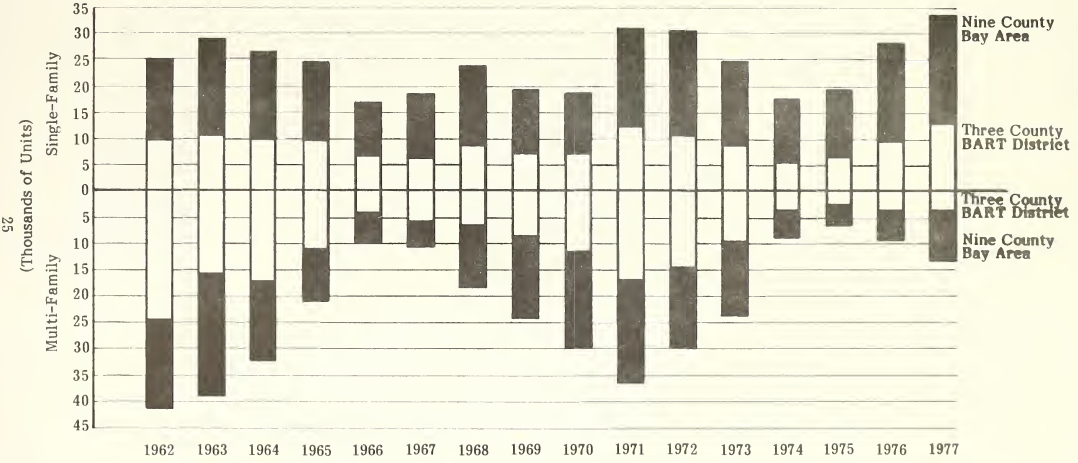
				Percent Change	
Area	1970	1975	1990	1970-75	1975-90
Alameda County	1,073	1,090	1,163-1,180	1.6	6.7-8.3
Contra Costa County	558	583	691-774	4.5	18.5-32.8
San Francisco County	716	673	642-645	-6.0	-4.4
Bay Area (9-County)	4,628	4,829	5,284-5,622	4.3	9.4-16.4

Source: U.S. Census and Association of Bay Area Governments (ABAG), Provisional Series 3 Projections (Berkeley, California, March 1977).

Housing permits are another measure of development patterns and provide excellent trend analysis for specific counties and cities over time. Permit data were used quite extensively in Work Element 5, the Study of the Housing Industry, and are summarized here.

11. There are two reasons why households are increasing at a much faster rate than population. First, average household size is declining as a result of fewer births; and second, the demographic structure of the population is such that the aging of the post-war baby boom generation is leading to increased household formation.

FIGURE 3. BAY AREA SINGLE FAMILY AND MULTI-FAMILY HOUSING PERMITS, 1962 - 1977.



Source: Security Pacific Bank, Construction Reports.

TABLE 4. THREE COUNTY AND BAY AREA HOUSEHOLDS, 1970, 1975, AND 1990 PROJECTION (Thousands of Households)

Area	1970	1975	1990	Percent Change 1970-75	Percent Change 1975-90
Alameda County	365	397	487-509	8.8	22.7-28.2
Contra Costa County	173	202	314-321	16.8	55.4-58.9
San Francisco County	295	299	308-309	1.4	3.0-3.3
Bay Area (9-County)	1,596	1,769	2,343-2,364	10.8	32.4-33.6

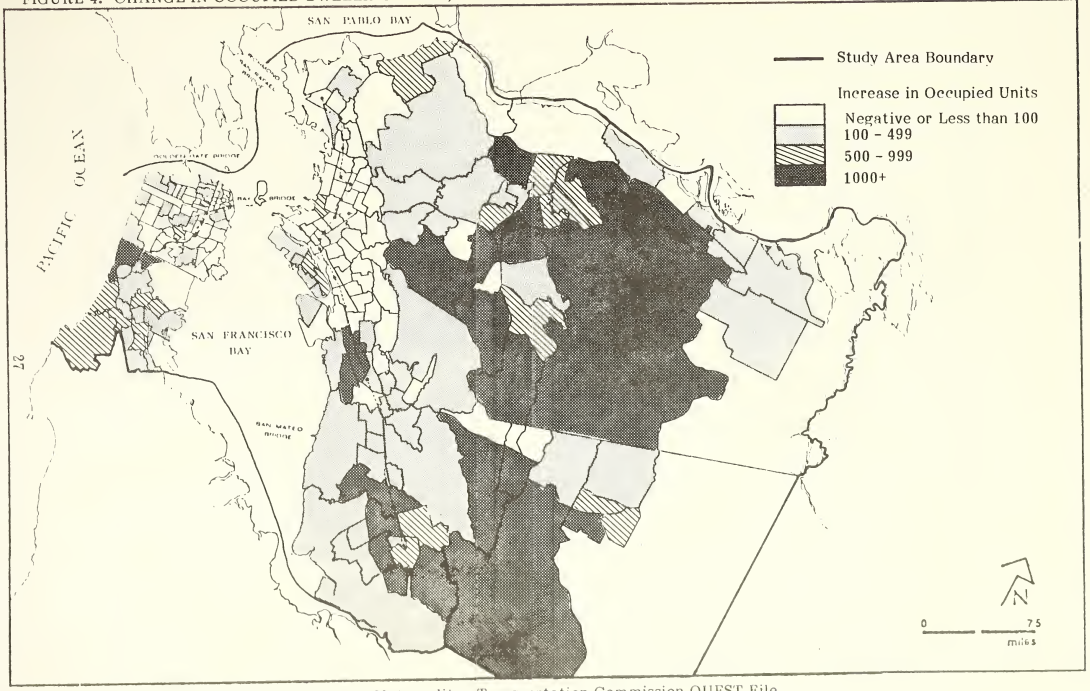
Source: U.S. Census and Association of Bay Area Governments (ABAG), Provisional Series 3 Projections (Berkeley, California, March 1977).

Housing permits in the Bay Area have fluctuated considerably over the past 15 years, particularly in multi-family housing. Chief reasons for the fluctuations have been changing economic conditions, interest rates, the availability of mortgage financing, construction costs, and consumer demand. As Figure 3 illustrates, Bay Area permits for single family homes have varied from a low of 16,700 in 1966 to a high of 34,000 in 1977. Multi-family housing permits ranged from a high of 41,600 in 1962 to a low of 6,700 in 1975, a much larger swing than for single family. Trends in multi-family housing in the BART service area counties have been similar.

The particularly low number of multi-family units since BART has begun service indicates one reason why BART has had little effect on residential housing clustering around stations. In fact, little higher density housing has been built anywhere in the Bay Area since 1971. High vacancy rates, a desire for single family homes, environmental concerns, and poor sales records for some notable examples of higher density sale housing have discouraged developers from attempting large complexes near BART stations.[12] Fear of rent control, the failure of rents to keep up with purchase prices, and a lack of land available for multi-family housing construction have also been cited as reasons for the diminished apartment construction in recent years.

12. Slow sales rates have occurred in several Bay Area high density condominium developments, including projects in downtown Oakland, San Francisco, and Albany.

FIGURE 4. CHANGE IN OCCUPIED DWELLING UNITS, 1970 - 1975



Source: Association of Bay Area Governments--Metropolitan Transportation Commission QUEST File

TABLE 5. EMPLOYMENT TRENDS IN THE SAN FRANCISCO BAY AREA, 1965-1975

County	1965 Employment	1975 Employment	Numerical Change	Percent Change
Alameda	386,500	434,300	47,800	+12.4
Contra Costa	124,300	160,100	35,800	+28.8
Marin	43,800	55,700	11,900	+27.2
Napa	23,300	28,600	5,300	+22.7
San Francisco	464,100	495,400	31,300	+6.7
San Mateo	168,800	225,100	56,300	+33.4
Santa Clara	306,600	517,800	211,200	+68.9
Solano	48,100	52,300	4,200	+8.7
Sonoma	55,500	77,300	21,800	+39.3
Total Region	1,621,000	2,046,600	425,600	+26.3
Special Areas				
BART Service Area	1,013,177	1,143,895	130,718	+12.9
BART Corridor	644,414	727,938	83,524	+13.0
Rest of Region	607,733	902,674	294,941	+48.5

Source: Association of Bay Area Governments

Employment trends are also useful for understanding BART's impact on development patterns. Employment in the nine counties of the San Francisco Bay Region was approximately 2 million in 1975. In the same year employment in the three BART counties was 1.1 million persons, or 53 percent. Five years before, in 1970, the same three counties accounted for 58 percent of the region's total employment, and in 1960 the share was even greater, 64 percent. This decline in the regional share of employment primarily is attributable to rapid growth in the South Bay —the San Jose metropolitan area -- and not to "slow" growth in the BART counties (see Table 5). Between 1965 and 1975 employment in the BART counties and in the BART corridors has increased at almost the same rate — 13 percent — suggesting that improved accessibility has not had a positive impact on employment change in areas near BART stations, although it may have precluded a decline in growth. This analysis does not address whether there have been distributional effects within the BART corridors -- an intensification of employment in one area at the expense of another.) Also, city-wide employment data for central cities tends to obscure changes in employment characteristics, namely an increase in white collar, downtown, BART-related employment being offset by a decrease in manufacturing employment.

BART IMPACTS ON TRAVEL

To what degree has BART affected travel patterns in the Bay Area? There is an extensive network of streets and highways in the Bay Area, as well as bus and transit systems of which BART is only one part. BART was not designed to serve the entire Bay Area, and analysis of the proportion of all trips that are made on BART in comparison to BART's penetration of the travel market for specific corridors clearly indicates where impacts would be most anticipated.

In 1975, approximately five million vehicle trips were made on an average weekday in the greater BART service area. About 30 percent of trips were for work purposes, 7 percent for business, 11 percent for school, 20 percent for shopping, and the remaining 32 percent for miscellaneous purposes. BART usage represented 2.4 percent of these trips, but 5.2 percent of work trips.[13] It must be considered, however, that most trips in the BART service area are not easily made on BART. There have been several measures of the proportion of possible trips on BART that are actually taken on BART. According to respondent perception as to whether a trip could have been made on BART, 11.2 percent of all trips in the three-county plus northern San Mateo County service area could have been made on BART, so BART was serving about 21 percent of its potential market.

Further research on the proportion of BART possible trips that are taken on BART show that there is a wide range of usage by corridor of residence and location of workplace. Focusing just on trips from the BART primary service area (132 zones) to work zones readily accessible by BART (88 zones), BART was used for 39.5 percent of all possible trips, 48.2 percent of possible trips to the San Francisco CBD, and 43.1 percent of all possible trips to the Oakland

13. For more on this, see Peat, Marwick, Mitchell & Co., Travel in the BART Service Area (Berkeley: BART Impact Program Transportation Systems and Travel Behavior Project, September 1977), p. 51.

CBD. Table 6 illustrates that BART's capture rate varies by corridor. From the Concord corridor to the San Francisco CBD BART serves about 55 percent of possible trips (those trips to a destination within walking distance of a BART station), while from the Richmond corridor BART serves only 16 percent of all possible trips to San Francisco, the difference presumably a reflection of no direct service from the Richmond line to San Francisco and competition from AC Transit from some areas.

TABLE 6. BART TRIPS AS A PERCENT OF BART POSSIBLE TRIPS, BART PRIMARY SERVICE AREA RESIDENTS

	Workplace Area		
Residence Area	San Francisco CBD	Oakland CBD	Total (including other destinations)
Daly City Corridor	51.9	54.6	48.2
Oakland Corridor	25.6	61.2	37.3
Richmond Corridor	16.2	35.5	27.4
Concord Corridor	54.9	43.8	35.8
Fremont Corridor	40.5	44.7	39.0
Express Bus Area[14]	41.9	26.9	28.8
Total	48.2	43.1	39.5

Source: MTC Workplace Survey, 1977.

14. Express bus service is available to BART from Pittsburg-Antioch, Livermore-Pleasanton, Pinole, and Dublin. Approximately 1,000 BART patrons used this service in 1975; in October 1977, daily ridership averaged 2,000.

BART usage has been greatest for trips to the San Francisco CBD and to the Oakland CBD, and for trips from the Concord and Daly City (residence) corridors. Therefore, it would be expected that BART impacts would have been closest to that anticipated in those areas.

BART has reduced the number of automobile trips taken in the service area, but it has also decreased bus usage. At the same time it has also increased mobility and therefore increased the net number of trips taken. For example, of patrons of BART transbay service, 46 percent drove, 46 percent used the bus, and 8 percent did not make the trip prior to BART service.[15]

In conclusion, BART's effects on areawide travel are relatively small. BART, however, has captured a significant share of travel in several well-defined travel corridors, such as from the Contra Costa corridor to downtown San Francisco. Therefore, the analysis of BART's effects on development patterns will focus on those areas where BART is a highly significant mode.

In the analyses of BART's effects on development patterns, as well as other research of the BART Impact Program, comparison is made to the No-BART alternative (the NBA), the MTC defined regional bus system improvements that might have existed in the absence of BART. These are defined as being small improvements to the level of bus service existing in 1971 prior to BART's opening. This assumed hypothetical NBA would not provide as extensive transit service as is currently provided by the BART system, and would not be capable of carrying current total transit ridership.

15. Peat, Marwick, Mitchell and Co., BART's First Five Years: Transportation and Travel Impacts Summary and Conclusions (Berkeley: BART Impact Program Transportation Systems and Travel Behavior Project, April 1978), p. 25.

4. BART'S EFFECTS ON DEVELOPMENT PATTERNS

The land use effects of BART addressed by the research hypotheses are treated in this chapter in terms of demand effects and supply effects. Obviously, the two are related, but for some analyses it is useful to consider the differences. For example, BART property acquisition affected the supply of housing, while changes in transportation costs may affect the level of demand for housing in a particular area. The first two hypotheses deal with the locational effects of demand for housing and commercial space, and whether these have been related to BART. The third and fourth hypotheses are concerned with BART's effects on the supply of housing in the BART corridors, and the effect on overall regional land use patterns. The fifth hypothesis specifically deals with BART's effects on minority employment opportunities.

POPULATION

HYPOTHESIS 1. BART has reinforced existing resident population movement trends, in particular increasing migration to outlying areas where new housing is available within acceptable commute distance.

This hypothesis was examined with four sub-hypotheses, dealing with improvements in accessibility, migration from central cities to suburbs, increased rates of commute to central cities, and differences in effect on white and minority households.

Hypothesis 1-A. Areas with the greatest accessibility improvement and closest to BART stations were also the areas with the largest increase in population.

Given the trend toward suburbanization, has BART affected this growth? Two tests were run on this hypothesis. Evidence from a regional regression analysis does not confirm this based on analysis of zonal population increase within the greater BART service area. However, a correlation analysis between accessibility gains attributable to BART and population increase aggregated to the municipal level in Contra Costa and Southern Alameda counties suggests that there has possibly been some relationship.

Regression Analysis

Four regression analyses were run on 1970-75 data. These used absolute change and percent change in residential population, and absolute change and percent change in employed residents (since households without workers are not influenced by journey to work in their locational decisions) as dependent variables and the relative availability of developable land, the inverse of the distance to the closest CBD, and the BART, highway, and other transit influences as

the independent variables. The BART influence was not significant for either absolute or percent change in residential population. The highway influence, developable land, and the constant are significant for both, and the distance to the closest CBD is significant for the percent increase only. In both cases, the highway and developable land influences have the expected signs, as does the CBD influence term in the percent increase equation. The BART influence did not correlate with other coefficients in the model. The equations and matrix of correlation for the coefficients are given in Appendix D (see Equations D-1 and D-2).

For the equations on employed residents, the same variables are significant. The BART influence is almost significant in the absolute change equation, and the highway influence is stronger here than in the population change equation, as might be expected. However, because of apparent autocorrelation, the null hypothesis that BART is not significant cannot be rejected. (See Equations D-3 and D-4.)

Accessibility Analysis

The second analysis was conducted using population increase (percentage) for selected suburban cities in Contra Costa County and for Fremont and Union City in Alameda County and accessibility changes attributable to BART. These locations were used because they had special censuses conducted in 1974-75, and were located near BART lines or beyond end stations. Although there could be other covariant factors that are more important causally, a correlation analysis between the total population growth and the net percent change in accessibility between BART and the NBA to downtown San Francisco and downtown Oakland yielded correlation coefficients of .63 and .28 respectively. The former is significant at the .95 confidence level, the latter is not.

One interesting trend is evidence that black households are moving to some suburban communities. Although the actual proportion of blacks in most suburban communities still is very low compared to whites, black populations were growing proportionally much faster than white in many of the areas, including most dramatically Union City where the black population increased by 8 times while the white population just about doubled. Fremont was another community where the increase in black population was proportionally greater than the white population gain. In Pinole and El Sobrante, two other suburban cities, the black population increased by over 100 percent, while the white population declined slightly (see Table 7). The correlation coefficient for accessibility change and population increase was slightly higher for blacks than whites — .68 in San Francisco and .48 in Oakland for blacks, compared to .59 and .23 respectively for whites.

As black use of BART is proportionally greater than white in Fremont (5.7 percent of black household heads use BART for their journey to work, compared to 3.4

TABLE 7. POPULATION CHANGE 1970 TO 1975 AND NBA/BART ACCESSIBILITY IMPROVEMENT TO DOWNTOWN SAN FRANCISCO AND OAKLAND

City	Population Change 1975/1970[a]			Accessibility Improvement with BART to[b]	
	Total	White	Black	San Francisco	Oakland
Antioch	1.18	1.16	4.74	.94	1.01
Pittsburg	1.06	1.04	1.03	.94	1.02
Concord	1.10	1.09	2.70	1.28	1.55
Martinez	1.07	1.05	1.41	1.29	1.00
Walnut Creek	1.16	1.15	2.76	1.18	1.31
Orinda	.98	.98	.97	.89	.97
Pinole	1.01	.95	2.03	1.12	1.52
El Sobrante	.84	.81	2.12	1.14	1.87
Richmond	.86	.93	.80	.89	1.25
El Cerrito	.91	.85	1.23	1.20	1.23
Fremont	1.14	1.10	4.07	1.97	1.91
Union City	2.04	1.89	8.29	1.85	1.75
Correlation Coefficient Population Change/Accessibility Improvement to:					
- San Francisco	.63	.59	.68		
- Oakland	.28	.23	.48		

Sources:

a. U.S. Census and 1974-75 Special Censuses for Contra Costa County, Fremont and Union City.

b. BART Impact Program — TSTB Project

percent of white), it appears that BART possibly has been a factor in black suburbanization, at least in this community. A similar relationship was found in Union City suggesting this may not be an isolated occurrence. Analysis of the 1974 Fremont Special Census provided some explanation of this apparent effect.[16]

As was indicated in the overview, BART serves some work trips in the service area very well and others very poorly. For example, of work trips by heads of households in Fremont in October 1974, 3.2 percent of all work trips were on BART, ranging from .2 percent of trips to other Fremont destinations, to 15.4 percent of Oakland-Berkeley-Alameda work trips, and 21.8 percent of San Francisco work trips. There were substantial differences in work location by ethnic status for Fremont residents as Table 8 indicates; thus, while 9.9 percent of white Fremont residents worked in Oakland-Berkeley, and 5.4 percent worked in San Francisco, the equivalent percentages for black Fremont residents were 17.2 percent and 8.7 percent respectively. Finally, while only 3.1 percent of white Fremont residents moved from Oakland between 1970 and 1974, 19.3 percent of black residents moved from Oakland during that period.

Consequently, higher BART patronage among blacks in Fremont most likely is related to their employment in Oakland, and secondarily San Francisco, rather than a different propensity to use BART for similar trips. A higher proportion of blacks in Fremont do work in BART accessible employment locations, and thus their moves may be attributed to some degree to BART. (Confirmation of this finding will require further research since black Fremont households were not surveyed in the study of BART's effects on households' location decisions.) More limited housing opportunities also may explain why blacks select Fremont or Union City; higher income whites have greater choices.

In conclusion, the lack of identifiable BART effect in the zonal regression analysis suggests that any effect on residential population in suburban communities is not specifically related to station area zones. This is consistent with the findings in the studies of BART's effects on the housing industry and households' location decisions.[17] It does appear, however, that BART accessibility

16. The California Department of Finance provided John Blayney Associates with previously unavailable tabulations from the 1974 Fremont Special Census. (Tabulations were based on trips by heads of households only. This eliminates potential analysis of trip patterns of secondary or equal workers, resulting in a sex bias -- a factor that should be considered in interpreting Fremont household heads data.)

17. See John Blayney Associates/David M. Dornbusch & Co., Inc., Households' Location Decisions and The Housing Industry.

improvements over the NBA may correlate with suburban growth at the more aggregate city level. Finally, BART does not seem to be responsible for "white flight" away from the central cities, thereby increasing the degree of housing segregation. To the contrary, the Fremont data suggests that black movers to Fremont may be more influenced by BART than white movers to Fremont as a result of their higher propensity to commute to BART accessible downtown workplaces. While black suburban population still is very low, it is increasing, and thus may be related to BART accessibility along with other factors.

TABLE 8. ETHNIC STATUS BY WORKPLACE:
FREMONT HEADS OF HOUSEHOLDS (Percent Distribution)

Ethnic Status	Total Respondents	Work Location: Fremont	Union City/ Hayward	Oakland/ Berkeley	San Francisco
White	28,678	25.5	15.8	9.9	5.1
Spanish	1,970	28.9	20.4	8.6	2.7
Black	471	18.9	14.4	17.2	8.7
Chinese	247	23.1	9.3	11.7	15.4
Other	1,601	22.2	14.9	11.1	5.6
No Response	2,446				

Source: Fremont Special Census, 1974.

Hypothesis 1-B. **Suburban residents who moved from inner or central cities are more likely to view BART as important than suburban respondents who have moved from other areas.**

Although it was hypothesized that former central city residents would be more interested in BART as a result of more prior experience on transit, analysis of the data did not support this hypothesis.

If BART contributed to growth in suburban areas, it might be expected that movers to those areas from inner city areas would attach more importance to BART than movers from other areas. This was tested with analysis of prior

residence and BART importance for respondents to the Household Survey who moved to Walnut Creek. There were two interesting results; first, that only 11.6 percent of the Walnut Creek movers had moved from San Francisco, Oakland, Berkeley, or Richmond; and second, that there was no statistically significant difference in importance placed on BART between residents moving from an inner or central city and other movers, as Table 9 illustrates. Thus, this survey demonstrates that, at least among Walnut Creek residents, recent movers from central cities were not motivated more by BART than other movers. In fact, a fairly high proportion of both groups considered BART a major factor in residence choice.

TABLE 9. BART IMPORTANCE IN RESIDENCE CHOICE IN WALNUT CREEK: INNER CITY MOVERS VS. OTHERS

Former Residence	Total Respondents	Percent Considering BART of Major Importance in Residence Choice
Inner City Movers[b]	20	30.0
Other Movers	153	32.0[a]
Total	173	31.8

a. No significant differences at the 0.95 level in terms of former residence.
b. Moved from San Francisco, Oakland, Berkeley, or Richmond

Source: Walnut Creek Household Survey

Using the MTC Workplace Survey, mode was examined by former residence location for six specific suburban zones. For respondents living in Walnut Creek-Concord and Orinda-Lafayette, there was a higher usage of BART among those who had moved from outside the Bay Area than there was among those who had moved either within the same city or within the Bay Area. For the other areas tested (Antioch-Pittsburg, Fremont-Union City, Pinole-El Sobrante, and Daly City-Pacifica) there were not statistically significant differences in BART usage by prior residence location.

TABLE 10. MODE BY FORMER RESIDENCE:
WALNUT CREEK-CONCORD RESIDENTS

Former Residence	Total Respondents	Percent Using BART
Bay Area		
- Same City	162	21.0
- Different City	410	21.7
Outside Bay Area	167	34.1[a]

a. Significant difference at the .95 confidence level between Bay Area and non-Bay Area former residence.

Source: MTC Workplace Survey, 1977.

Given the above data, BART is a factor in the decision to move to suburban areas from Bay Area central cities. However, BART is of equal importance to movers within or between suburban communities, and actually of greater importance to movers from outside the Bay Area. The increased propensity to use BART for those Walnut Creek-Concord respondents who moved from outside the Bay Area seems to be related to work location: Among Walnut Creek respondents to the Household Survey, 44.3 percent of those who moved from outside the Bay Area worked in San Francisco, while only 19.6 percent of movers from elsewhere in the Bay Area were employed in San Francisco. The higher propensity to use BART among commuters to San Francisco would explain the difference. Two reasons may explain why a higher proportion of movers from outside the Bay Area would work in San Francisco. First, employees being transferred into the area would be more likely to be engaged in headquarters' type office functions, activities that San Francisco specializes in; and second, movers from outside the Bay Area may be from more central-city oriented areas and, therefore, concentrate their job search in San Francisco.

Hypothesis 1-C. **Since BART began service there has been an increase in the proportion of commuters to central cities from suburban communities served by BART.**

In some suburban areas served by BART, the propensity to commute to downtown San Francisco or Oakland since BART began service has increased, providing some evidence that patterns of centralization of employment and suburbanization

of residences have been facilitated by BART. Table 11 indicates the work location by time at residence for respondents to the MTC Workplace Survey living in selected suburban zones. (Only persons employed in a work zone accessible by BART were included in this survey.) The proportion of respondents commuting to San Francisco among those who have lived at their residence under three years is higher in every case except for Pinole-El Sobrante, but only in Walnut Creek-Concord and Fremont-Union City are the differences significant at the .95 confidence level. For Pinole-El Sobrante the proportion commuting to Oakland is significantly higher among those at their residence under three years.

TABLE 11. EMPLOYMENT LOCATION BY TIME AT RESIDENCE, SELECTED SUBURBAN RESIDENTIAL AREAS (Percent Distribution)

	Employment Location and Time at Residence					
	Total Respondents		San Francisco		Oakland	
Residential Area	Under 3 Years	3+ Years	Under 3 Years	3+ Years	Under 3 Years	3+ Years
Orinda — Lafayette	62	109	20.6	18.5	49.0	43.5
Walnut Creek — Concord	413	338	27.6[a]	15.9	27.8	31.8
Antioch — Pittsburg	48	27	25.0	22.2	10.5	3.7
Fremont — Union City	258	291	16.2[a]	10.0	33.6	31.1
Pinole — El Sobrante	62	43	38.7	41.9	25.8[a]	14.0
Daly City — Pacifica	120	124	95.0	87.7	1.6	4.8

a. Significant difference at the .95 confidence level; others are consistent, although not significant at that level.

Source: MTC Workplace Survey, 1977.

The results shown in Table 11 may indicate that San Francisco and Oakland workers have been willing to seek housing in more outlying communities than otherwise since BART has been in operation. While BART patronage may not have shown any effect, the hedgers (those who were affected by BART but who are not users) may show up when service levels improve or highways become more congested. The relative importance of San Francisco and Oakland workplaces also was computed for each residential area. Much higher proportions of Orinda-Lafayette and Fremont-Union City residents work in Oakland than in San Francisco, while the reverse is true for those living in Antioch-Pittsburg, Pinole-El Sobrante, and of course, Daly City-Pacifica. Thus, based on this evidence, the hypothesis can be supported; some suburban communities do have an increasing central city commute orientation.

Hypothesis 1-D. In selecting a residence location, white households that move are motivated more by BART than minority households.

Although evidence is mixed on this hypothesis, differential ethnic perceptions of BART stem more from differences in residential location than any ethnic factor per se.

BART was indicated as the most important reason for selecting a neighborhood by 1.9 percent of the white respondents, 5.0 percent of the Asian respondents, and none of the black or Spanish heritage respondents to the Household Survey, but these results were not statistically different (small sample size of minority respondents limited the analysis).

When respondents were probed further as to whether BART was a major consideration, minor consideration, or not a consideration in location choice, differences were evident between ethnic groups. White and Asian respondents took proximity to BART into account more frequently than black or Spanish heritage respondents (see Table 12). Blacks evidenced the lowest concern for BART, with only 20 percent indicating that proximity to BART was a major or minor consideration in residence choice. By contrast, 50 percent of the white and Asian respondents stated that BART affected their locational decisions.

However, given BART's importance in Walnut Creek where few minorities live, this result would be expected. The limited sample also probably affected response, confirming that differences in residence location are probably the key reason why non-minority households were more affected by BART. Review of Fremont Special Census results indicates higher BART usage among black and Asian household heads than among white or Spanish heritage household heads, a factor that seemed related to the differing nature of work trips for these groups (a higher central-city orientation) — see Table 13. Therefore, given residence location, white households do not seem more motivated by BART.

TABLE 12. RELATIONSHIP BETWEEN ETHNIC STATUS AND THE IMPORTANCE OF BART IN RESIDENCE CHOICE

Ethnicity	Total Respondents	Importance of BART in Residence Choice (Percent of Total) Major Consideration	Minor Consideration
White	264	23.9	28.0
Spanish	16	18.8	18.8
Black	15	13.3	6.7
Asian	19	26.3	36.8
(Non-Response)	(1)		

Source: Household Location Survey

TABLE 13. BART USAGE BY ETHNIC STATUS, WORK TRIPS OF FREMONT HEADS OF HOUSEHOLDS

Ethnic Status	Total Respondents	Percent BART Primary Mode
White	28,678	3.4
Spanish Heritage	1,970	1.9
Black	471	5.7
Asian	795	4.7

Source: Fremont Special Census, 1974.

In conclusion, BART has not been responsible for decisions to move, but has affected community or neighborhood choice (along with many other factors) among movers to or within suburban communities. There is no difference, however, among movers within the suburbs or those from central cities. Growth rates of population from 1970 to 1975 have been higher in cities where BART improved access in comparison with the NBA, and BART's influence may have encouraged some San Francisco and Oakland workers to move to more outlying communities than they would have considered otherwise. The evidence as to whether BART has affected moves of white households to a greater degree than minority households is somewhat contradictory. While black respondents to the Household Survey seemed to indicate less BART impact, the relationship between black suburban growth and BART's accessibility improvement is greater than that calculated for white population growth.

EMPLOYMENT

HYPOTHESIS 2. BART has reinforced existing trends toward centralization of regional office employment in San Francisco.

As suburbanization occurred in the Bay Area, population serving employment also migrated from the central cities. Most dramatic has been the trend in retail trade. Over the past 20 years, downtown San Francisco employment in retail trade has declined by over 4,000 jobs, falling from 39 percent to 20 percent of the region's total retail employment.[18] In total employment, the increase for San Francisco County has been far behind the region as a whole. From 1960 to 1970, total employment increased by 12.7 percent, while regional employment increased by 37 percent. The 1962 Composite Report indicated that BART would help "maintain and encourage profitable concentrations of business and industry."[19] Has it had this effect?

To answer this question, two sub-hypotheses were formulated and tested, focusing first on BART's impact on three county employment trends and then specifically on trends in San Francisco CBD employment.

Hypothesis 2-A. Employment opportunities in the BART service area have increased in relation to distance to BART stations and accessibility gains with BART.

Using the MTC regional data base, regression analyses were conducted for 1970-75 changes in employment that BART was considered likely to have affected.

18. Jacobs & McGill, An Analysis of BART Related Joint Development in San Francisco (San Francisco: unpublished SPUR study, January 1976), p. 22.

19. Parsons, Brinckerhoff, Tudor, Bechtel, Composite Report - Bay Area Rapid Transit, p. 76.

The results from this analysis did not allow us to reject the null hypothesis that BART has had no positive effect on employment patterns. For retail trade, business service, and retail service employment, distance to the closest CBD was the key significant variable (i.e., "explained" the most variation in the change in employment). In several of the equations, the coeffficient of the BART effect variable was not significant (i.e., the data and the equation did not show any significant effect of BART on employment growth). In other equations, BART's effect was significant but with a negative sign. However, BART's effect was strongly related to and collinear with the CBD effect, suggesting that BART's influence must be examined jointly with the CBD effect. In one case, BART's effect was significant with a positive sign, but again collinear with the CBD variable. In another equation, BART's influence was significant and negative, and was not multicollinear with the CBD effect. This last finding suggests that further analysis would be fruitful to test the hypothesis that BART has a negative influence on particular types of employment. Summaries of the equations follow, and the equations and correlation matrices of coefficients are given in Appendix D.

Retail Trade Employment (Equations D-5 and D-6)

The BART influence variable was significant, but had a negative sign. The CBD effect was positive and the most significant variable. There was positive multicollinearity of .526 between the coefficients for CBD and BART influences, suggesting that the two must be considered together. Possibly the equation is detecting BART construction impacts on retail employment stemming from disruption along Market Street, in the Mission District, and in downtown Oakland.

The CBD influence had the strongest effect on the percentage increase in retail trade employment. The constant and the BART influence also were significant, the latter with a negative sign.

Business Service Employment (Equations D-7 and D-8)

The BART variable was not significant in either regression. The highway, transit, and CBD influences were significant in both the absolute and relative change equations, and the amount of developed land was significant in the percent or relative change equation. The highway effect was negative, while the CBD and transit effects were positive. In both cases the CBD influence had the greatest effect, and in both cases the coefficient for BART influence had high multicollinearity with the CBD effect, which might account for the lack of statistical significance. The CBD variable may contain all or most of the BART effect.

Retail Service Employment (Equations D-9 and D-10)

The BART influence was significant in both cases, but the influence was negative for absolute change and positive for percent change. The CBD influence was positive and significant in both equations, and the highway influence was negative in the absolute change. In the percent change regression, the BART influence and CBD were highly multicollinear, and this may cause the sign change between the two equations as could autocorrelation in the absolute change equation. Further research would be necessary using different variables to overcome the inconclusiveness resulting from the multicollinearity.

Federal and State Government Employment

Only the constant was significant in these two models, and it only "explains" 3.3 percent of the absolute change and less than one percent of the percentage change in government employment. A substantial number of zones had no employment in this category,suggesting that the specification of the model would need further refinement.

Finance, Insurance, Basic Business Services

This category of employment includes insurance companies, education, and miscellaneous business services. No variable was significant in explaining variations in this category. Limitations in the classification and the potential dominance of educational employment which was rather dispersed are the likely reasons for the lack of any relationship.

The equations are not presented in the appendix for government and finance-insurance, etc., employment, since there was so little variation explained by the independent variables used.

Further research would be required to determine conclusively whether and how BART has affected regional employment. The models did not identify a BART influence independent of the CBD influence.

Employment categories containing non-transit related jobs and multicollinearity of the BART influence with the CBD effect had major effects on these models. Spatial autocorrelation also affected these results. Additional variables that stratify the data may eliminate this problem.

Hypothesis 2-B. **Employment opportunities have expanded more in San Francisco than elsewhere in the region as a result of BART.**

During the past 15 years the percent of total regional employment in the downtown San Francisco CBD has been increasing. While no key informant indicated

BART was the most important criterion for a decision to locate or build in San Francisco, increased corridor capacity, the Market Street Development Project, and changes in downtown zoning, all of which were related to BART, have contributed to San Francisco's continuing vitality as a central city and place to conduct business.

As Table 14 indicates, San Francisco CBD employment increased 47 percent between 1960 and 1970, and an additional 13 percent by 1975, compared to 37 percent and 9 percent respectively for the nine-county Bay Area. During this time, San Francisco CBD employment increased from 7.9 percent to 8.8 percent of total regional employment. This is quite contrary to trends in other American cities. As further evidence of a growing concentration in downtown San Francisco, 72 percent of the total employment increase in San Francisco between 1970 and 1975 took place in those zones adjoining the four downtown stations.

Many reasons have been given for the tremendous growth in office space and employment in downtown San Francisco. Existing firms have expanded and firms have moved to San Francisco from other regions and from other Bay Area communities. Reasons cited have included excellent access by both public transportation and the automobile, the image and prestige of a San Francisco address, the availability of shops and restaurants, the necessity to deal with other nearby firms, and the opportunity for corporate involvement in community affairs.[20]

Most development decisions build on prior decisions. As long as office vacancy rates in San Francisco remain low, there is an economic demand for additional space, with BART perhaps not a perceived factor. Some of the earlier trend setting investment decisions in San Francisco were made by corporate leaders who also were strong BART supporters. BART, urban renewal, and urban beautification were all undertaken to ensure the continued business viability of the city.

While no key informant cited BART as the sole reason for a San Francisco office location, BART has substantially increased corridor trip-carrying capacity in an already somewhat congested environment, and contributed to the positive image of San Francisco as a place to do business. Without increases in corridor capacity, future development in the San Francisco CBD would be constrained by traffic congestion, and therefore the CBD proportion of Bay Area employment would be expected to decline. BART forestalls decentralization by adding transit capacity to the downtown and thereby lowering the cost of commuting to established business districts.

20. See John Blayney Associates/David M. Dornbusch & Co., Inc., Employers' Locational Decisions (Berkeley: BART Land Use and Urban Development Project Working Paper, March 1978), p. 9.

TABLE 14. EMPLOYMENT IN THE SAN FRANCISCO CBD AND NINE-COUNTY BAY AREA, 1960, 1965, 1970, AND 1975.

	San Francisco CBD[a]	Nine-County Bay Area[b]	San Francisco CBD as Percent of Nine-County Bay Area
1960	115,000	1,452,400	7.9
1965	137,000	1,675,700	8.2
1970	169,000	1,985,400	8.5
1975	192,000	2,170,400	8.8
Percent Change, 1960 - 1970	47	37	
Percent Change, 1970 - 1975	13	9	

Sources:

a. Keyser Marston Associates estimate, in Impacts of Intensive High Rise Development on San Francisco, San Francisco Planning and Urban Renewal Association (SPUR), San Francisco, California, June 1975.

b. California Employment Development Department.

Note: Comparable data did not exist for downtown Oakland.

There has been a definite trend for new office space in San Francisco (and Oakland) to locate in BART station areas. In San Francisco, BART alone was not responsible for this trend toward and across Market Street from the traditional financial center, but BART and related changes in zoning and the Market Street Development Project did influence some firms' or developers' locational decisions. In Oakland, BART was a key factor in the expansion of the City Center Project which consequently attracted new office development to the 12th Street Station area.

In conclusion, employment growth in the BART service area seems to have been greatest in or near the established business districts. However, while many of these centers have BART stations, the BART influence factor in the regression analysis did not show a separate, unique BART impact which could be isolated for the CBD impact. The San Francisco CBD has grown substantially both in absolute numbers and as a proportion of regional employment, and BART's ability to increase corridor capacity has probably forestalled decentralization of business and employment from San Francisco. BART is not perceived as a direct causal factor in San Francisco employment growth, but it was a contributing factor in the continued confidence which encouraged CBD investment.

HOUSING

HYPOTHESIS 3. BART has induced an increase in the supply of housing in outlying areas.

BART was expected to have a pronounced effect on the supply and quality of housing in the Bay Area. Impacts cited in the 1962 Composite Report included: facilitating suburbanization and therefore inducing housing in outlying communities and developing clusters of higher density housing in station areas.[21] Analysis of some of these effects, as well as analysis of some other expected impacts, is contained within the following sub-hypothesis.

Hypothesis 3-A. Housing built because of BART has been in outlying areas, while housing removed by BART construction was primarily in older, closer-in areas.

Analysis of permit data, key informant interviews, and BART's property acquisition files does not allow us to reject this hypothesis. Over 50 percent of housing removed by BART was in older, central areas, while most of the new housing that was apparently induced by BART is in suburban areas.

It is easier to catalogue the losses to the housing supply resulting from BART acquisition than it is to tabulate the number of units added to demand in specific areas as a result of BART. Additions to supply induced by BART can only be approximated for areas that were specifically studied in other work elements of the Land Use and Urban Development Project.

Altogether, BART acquired 3,004 units of housing. Of these 1,435 were single family, and 1,568 were in multi-family units. Not all of these units were lost to the housing stock. Approximately 600 structures (mostly single family and duplex) were relocated, so the net loss of housing as a result of BART construction was about 2,300 units.

21. Parsons, Brinckerhoff, Tudor, Bechtel, Composite Report - Bay Area Rapid Transit, p. 82.

Analysis of BART's acquisition by corridor segment indicates that 58 percent of single family units bought by BART were in urban rather than suburban communities. (Suburban was defined as San Leandro and south on the Fremont line, and Orinda and east on the Concord line.) Also, 86 percent of multi-family units acquired were in urban areas. Average value for the single family housing acquired was $18,500 at the time of purchase (mostly 1965-67) ranging from a low of $13,400 in Richmond to a high of $24,000 for the Orinda to Concord segment. Average values in Oakland, the Richmond line with the exception of Richmond, and the Daly City line were higher than for those homes on the Fremont line south of Oakland. No data is available for ethnic status of displaced households, but 15 percent of residential units acquired were located in minority census tracts (defined as any census tract with a black or Spanish surname population of at least 40 percent of the tract total).

Approximately 250 units have been built or committed to date on BART surplus lands (150 units in downtown Oakland, and 100 units on scattered sites). BART's effect on total Bay Area demand for housing has been approximately 4,300 units. This includes the 2,300 net households who lost housing as a result of BART demolition, and 2,000 additional households resulting from the direct and multiplier effects of net BART employment.[22] As the majority of new housing construction in the Bay Area has been in suburban areas, and there has been no apparent clustering of new housing around any BART stations, new housing induced by BART has been primarily in outlying areas.

Few major developers (suppliers of new housing) interviewed indicated that they were affected by BART.[23] However, five of 25 developers did indicate that BART affected their choice of a specific site, timing or density. Three of the five developers operated in Walnut Creek, one in Pittsburg, and one in Fremont. Table 16 gives some details on the completed and anticipated projects. Approximately 1,300 units of single family sales housing, and 1,100 units of multi-family rental housing have been completed to date in these projects.

Several other developers currently are planning projects that have been affected by BART. The largest project would be 712 units of high density condominiums (50 units per acre) very close to the Fremont station. The density is very high for the Fremont area, but represents a minimum density allowable under current Fremont zoning for the area.

Other indirect BART impacts on housing include the demolition of housing in redevelopment projects expanded as a result of BART credits. Approximately 1,000 units were removed in Oakland and Richmond in such areas, and all occupants were relocated under conditions of the federal Uniform Relocation Act.

22. See McDonald and Grefe, The Economic and Financial Impacts of BART, (Berkeley: BART Impact Program, 1978), p. 50. This report estimated that 3,000 new jobs occurred in the region as a result of BART. Assuming that 50 percent of households have two workers, this would translate to 2,000 additional households.

23. For details, see John Blayney Associates/David M. Dornbusch & Co., Inc., Study of The Housing Industry.

One project of 173 units has been completed within the Richmond redevelopment area, and additional housing is slated for both Oakland and Richmond.

TABLE 15. BART ACQUISITION OF HOUSING BY AREA, TYPE, AND VALUE

Area	Single Family Housing		Multi-Family Housing
	Number	Average Value[a]	Number
Urban			
San Francisco-Daly City	260	$19,700	24
Oakland	180	17,300	740
Berkeley	141	17,900	376
Albany-El Cerrito	146	18,000	157
Richmond	111	13,400	59
Suburban			
San Leandro-Fremont	202	$14,000	24
Orinda-Concord	335	24,000	189
Total	1435	$18,500	1569

a. Value of unit at time of purchase, primarily 1965-1967.

Source: BART Real Estate Department

TABLE 16. RESIDENTIAL PROJECTS SIGNIFICANTLY INFLUENCED BY BART

Project	Location	Type	Number of Units	When Constructed	Nature of BART Impact
Diablo Keys	Walnut Creek	Apartments, all types $255-$600/month	788	1970-72	Deliberately located near BART, and timed to coincide with BART opening.
Bancroft Village	Walnut Creek	Townhouses, $77,000-$87,000	400	1976-79	Timing advanced one year.
Ranchos Medanos	Pittsburg	Single Family detached, $44,000-$57,000	900	1976-80	Location, timing, and density affected.
Stoneridge	Walnut Creek	Apartments, 1 and 2 bedroom, $240-$335/month	339	1970	Initial location and subsequent demand attributable to BART, at least in part.
Anonymous	Fremont BART line	Luxury apartments	300-400	1978+	Location and character heavily dependent on BART.
The Hub	Fremont	Condominiums, $60,000-$80,000	712	1978+	Location and density geared to a BART market.

Source: John Blayney Associates/David M. Dornbusch & Co., Inc., Study of the Housing Industry.

In summary, approximately 50 percent of single family homes acquired by BART were in suburban areas, but almost 100 percent of new sales housing directly affected by BART was probably built in suburban areas as there are few sites for single family homes in the urban areas. While 86 percent of rental housing acquired by BART was in urban areas, apparently almost all market rate rental housing influenced by BART has been in suburban areas. Downzoning in some urban areas that may have otherwise been redeveloped to multi-family housing (Rockridge, North Berkeley), contributed to this factor.

Hypothesis 3-B. Residential development in the BART service area was related to anticipated gains in accessibility by BART to jobs as well as the supply of developable land and highway improvements.

Regression analysis indicated a positive and significant relationship between the BART influence and both the percentage and absolute change in the number of occupied dwelling units in a zone; therefore, the null hypothesis that BART has had no effect can be rejected. The constant and the supply of developable land are also significant in the equation and with the expected sign (the negative coefficient for supply of land is because of model specification). It is interesting that neither the highway or other transit influences are significant, and yet BART is. The land availability variable has the strongest impact on the equation. The BART influence and constant are significant refinements to the equation, but do not by themselves "explain" a large proportion in the variation in occupied dwelling units. The BART influence is not covariant with any other variable. The coefficients and t scores for the equations are given in Appendix D (see Equations D-11 and D-12). The significant BART influence on occupied dwelling units but not on population is attributed to the stronger relationship of BART to household decisions, with households clearly correlated better to dwelling units than population would be. BART's greatest influence might be on small, multiple worker households, and their growth has had more impact on housing demand than on population growth.

Hypothesis 3-C. Land developed as a result of BART was "next in line for development" in any case, and BART did not cause urban sprawl.

Evidence from key informants, maps of urbanization, and analysis of building permits supports this hypothesis. No BART stations were located in areas where urbanization had not reached prior to the system. Only two station areas, Fremont and Union City, had a large amount of vacant land in station areas in 1965, although Pleasant Hill and South Hayward station areas also had some vacant land. All other stations were in previously built up areas, and only the Fremont and Concord corridors go into areas of recent and continuing suburban growth.

New housing directly induced by BART in Walnut Creek has consisted of infilling within already urbanized areas. The only area affected by BART that was previ-

ously perceived to be beyond commute distance to San Francisco and Oakland was possibly Antioch and Pittsburg. Livermore and Pleasanton have express bus service to BART stations, but a 1972 moratorium on issuing building permits has diminished any possible BART effect. Development in Antioch and Pittsburg which BART seems to have influenced has required extensions of streets and utilities; however, the growing shortage of developable land on the Bay plain coupled with the continuing preference for single family housing and completion of several major improvements to the regional highway system over the past 15 years has made residential development in these outlying areas inevitable with or without BART.

Continuing growth in other fringe areas such as the Santa Teresa-Morgan Hill area of Santa Clara County and the Petaluma-Cotati area in Sonoma County has not been related to BART. The growth in Antioch-Pittsburg seems more related to this overall trend than to BART specifically.

Hypothesis 3-D. **Increased employment outside the BART service area also was a major influence on residential development trends in the BART corridors.**

Key informant interviews, employment data, and traffic counts on the southern Bay crossings support this finding. Clearly there are other factors besides proximity to BART which influenced residential development along the BART corridors. The amount and price of developable land certainly are extremely important. Accessibility with BART is most improved for the Fremont-Union City area, and BART clearly did affect this growth. The amount of growth in this area, however, has been much greater than would be anticipated from examining BART patronage, or even considering that there are many hedgers -- those influenced by BART who are not now BART riders, but are potential future riders when highway congestion increases or costs of driving increase dramatically.

Key informants suggested that many of the people buying homes in the Fremont area moved over from the Peninsula, where housing prices greatly escalated[24] from higher initial prices, and there have been limited additions to the supply (Gilmetti, Schoesson). Another phenomenon affecting the demand for housing in Fremont is its position between Alameda County and Santa Clara County employment locations. One key informant (Brownlow) felt a substantial number of households had one worker who rode BART north, while the spouse drove to a San Jose job.

Employment growth in the Bay Area has been the most rapid in Santa Clara County (69 percent or 211,000 new jobs from 1965 and 1975) and San Mateo County (33 percent or 56,000 new jobs). The rate of change in usage of the San Mateo-Hayward Bridge and the Dumbarton Bridge supports a hypothesis of increased commuting from southern Alameda County to San Mateo and Santa

24. According to the Northern California Real Estate Report, the index of average home price on the Peninsula increased from 100.0 in April 1967 to 269.3 in April 1977, compared to 251.6 for southern Alameda County and 241.8 Bay Area-wide.

Clara counties. On the San Mateo-Hayward Bridge average daily midweek traffic increased from 13,000 vehicle trips in 1969 to 18,000 by 1976, an increase of approximately 6 percent a year. Peak hour two-directional traffic counts show more dramatic increases in volume, from 3,000 vehicles in 1970 to 3,900 in 1976 and 4,400 in 1977 — increases of 47 percent in seven years and 13 percent from 1976 to 1977. On the Dumbarton Bridge between Union City and Palo Alto-Menlo Park, the increases have been similar, from 1,200 vehicles per hour in 1970 to 1,350 in 1975, 1,450 in 1976, and 1,650 in 1977 — increases of 37.5 percent since 1970 and 14 percent in the last year. In comparison, the Bay Bridge carries much greater traffic volumes, approximately 92,000 one-way trips daily in 1977, and 8,200 one-way trips peak hour, but the growth rate has averaged only two percent annually.

There is also a substantial amount of carpooling within the Southern Alameda County-Peninsula commute corridor. According to the 1974 Fremont Special Census, 19.4 percent of Fremont heads of households who worked in San Mateo County carpooled, compared to an average of 6.7 percent for all Fremont household heads.

In conclusion, employment growth in Santa Clara and San Mateo counties has been a contributing factor to recent growth in the BART corridors, most specifically in the Union City-Fremont area.

Hypothesis 3-E. **By stimulating construction in outlying areas, BART has had the effect of decreasing demand for inner city housing, increasing minority migration to the Bay Area, and/or allowing minority households to occupy better housing than previously available.**

This hypothesis is not supported by analysis of survey results and key informant interviews. While BART may have influenced some households from inner city areas to move to outlying areas, this represented a minor proportion of those influenced by BART, and other factors more than offset this decreased demand for inner city housing. The movement of populations from cities to suburbs has been a general movement in cities throughout the country in response to a variety of economic and social factors. The development of BART was compatible with this trend. While BART did not cause this move, it served the move. Presently there are indications that the outward movement is being slowed and to some extent reversed.

If BART has served to encourage migration to suburban areas with all other factors equal, one might expect decreased demand for inner city housing which could have several effects, among them allowing minorities and lower income households to occupy better housing than previously available or increasing migration to the Bay Area by such households as a result of housing availability.

While previous findings indicated that BART has influenced some moves, there is a distinction that must be made between moves to suburban areas from Bay Area inner city areas, moves within suburban areas, and moves from outside the Bay Area. Among Walnut Creek respondents to the Household Survey, only seven percent moved from San Francisco, seven percent moved from urban and suburban locations in Alameda County, and 47 percent were movers within mostly suburban Contra Costa County. The remaining movers came from either other Bay Area suburban counties or from outside the Bay Area. Consequently, BART's effect on suburban movers from inner cities was quite small. If demand had decreased for housing in inner city areas as a result of BART's influence on moving decisions, vacancy rates would have increased and increases in property values would have been less pronounced. Between 1970 and 1974 vacancy rates did increase in San Francisco, Oakland, and Richmond in relation to suburban areas along BART lines, but these increases were not substantial, and in two of the three cases, vacancy rates came back down by 1977, as Table 17 indicates.

TABLE 17. IDLE RESIDENTIAL ELECTRIC METERS, SELECTED BAY AREA COMMUNITIES, 1970, 1974, AND 1977

Community	March '70	March '74	March '77
Alameda County	1.1	2.2	1.4
Oakland	1.5	4.0	2.3
Berkeley	1.1	1.4	1.4
Hayward	0.7	1.0	0.6
Fremont	0.7	0.8	0.5
Contra Costa County	1.6	1.8	1.0
Richmond	1.1	2.1	1.4
Concord	1.8	1.3	0.8
San Francisco County	1.5	2.4	2.3
San Mateo County	0.8	1.1	0.9
Daly City	0.7	0.9	1.1

Source: "Housing Vacancy Indicators for the San Francisco Bay Area and Sacramento Area Based on Idle Residential Electric Meters," Northern California Real Estate Report, 29, 1 (1977), pp. 18-19.

Property values have not declined, but may have increased at a lower rate in Richmond and East Oakland than in Fremont and Concord (Table 18). Property values in southeast San Francisco, which included the Mission, have increased almost as much as in the suburban communities.[25] Any loosening of the housing market in central cities because of household moves stimulated by BART has been offset by other trends, such as inflation, energy shortages, and an increased demand for city housing by middle to upper income white households — the so-called move back to the city.

TABLE 18. MARKET TREND INDEX: SINGLE FAMILY PROPERTIES, APPRAISED VALUE, SAMPLE SURVEYS BY NORTHERN CALIFORNIA REAL ESTATE COUNCIL

Community	April '67	April '70	April '74	April '76	April '77
Alameda					
Oakland: East	100.0	108.4	134.4	157.2	184.9
Oakland: North	100.0	112.6	149.9	180.8	233.4
Southern: (including Fremont)	100.0	115.8	152.8	194.6	251.6
Contra Costa					
Richmond	100.0	113.0	143.0	178.0	197.3
Concord	100.0	115.8	152.8	194.6	251.6
San Francisco					
Southeast[a]	100.0	107.0	142.5	205.2	240.2
Central[a]	100.0	100.2	135.9	177.3	238.6
Bay Area	100.0				241.8

a. Mission Street divides the two sections.

Source: "Trends in the Value of Residential Land and Improvement in the Bay Area and Sacramento Area," Northern California Real Estate Report, 29, 2 (1977).

25. As there is evidence of a decrease in real property prices around the 16th Street-Mission station, housing in other parts of southeast San Francisco must have increased at a faster rate than suburban communities. This subject is analyzed in detail in the forthcoming report by John Blayney Associates/David M. Dornbusch & Co., Inc., Study of Property Values and Rents.

Particularly in San Francisco, and to a lesser degree Oakland, there has been strong demand for old homes for refurbishing by young singles and couples. These people are choosing short commutes and city lifestyles over the suburban amenity package. Regardless of BART's effect on selecting an inner-city neighborhood, if BART has increased job opportunities in the central cities, it has increased the demand for nearby housing even by people who do not use BART.

If employment had decentralized to a greater extent as a result of congestion, possibly fewer of these workers would be choosing to live in inner cities to be close to work. Therefore, if BART has had the effect of increasing housing availability for minorities in central cities, it has been obscured and/or offset by other effects. The recent increase in minority population in Fremont also suggests that minorities as well as whites are possibly influenced by BART to move from inner cities.

Although it is fairly clear that there has not been a decreased demand for inner city housing, it also can be confirmed that there has not been an increase in minority migration to the Bay Area as a result of BART.

Examining the prior residence location of respondents to the Household Survey, one finds that a higher proportion of minority movers than white movers had a previous address in the Bay Area. While 73 percent of white respondents moved from another location within the Bay Area, 80 percent of Asian respondents and 100 percent of black and Spanish respondents moved from within the Bay Area.

Among respondents to the Workers Survey, 73 percent of white respondents who had moved residences previously lived in the Bay Area; this compares to 72 percent for black, 89 percent for Spanish, and 46 percent for Asian respondents. With the exception of the Asian respondents to the Workers Survey, there is no evidence to suggest that the hypothesis is correct, and the result for Asian respondents is not statistically significant.

In conclusion, there appears no evidence of decreased demand for inner city housing in San Francisco, and movement of white households out of Richmond or some areas of Oakland predated BART. Vacancy rates have not increased significantly in inner city areas, and there does not appear to have been increased minority migration to the Bay Area.

Hypothesis 3-F. **BART-induced down-zoning rather than lack of demand has been the principal deterrent to inner city station area redevelopment.**

Analysis of station area development trends and key informant interviews does not support this hypothesis. Nine BART stations have had a policy change to more restrictive zoning since 1965. These include Mission-16th Street, Mission-

24th Street, Oakland West, MacArthur, Coliseum, Rockridge, Berkeley, North Berkeley, and El Cerrito Plaza. Around only one of these stations, Berkeley, has any appreciable construction occurred, mainly non-residential development.

Around several inner-city stations, such as Richmond, the four downtown San Francisco stations, and the three downtown Oakland stations regulations have been amended since 1965 to permit more intensive development. There has been little private development around the Richmond station (Kaiser Medical Clinic, etc.). Public redevelopment plans for the Mission-24th Street area were withdrawn after community opposition that was spurred by a concern with the possible effects of BART. Small developers have done some remodeling and other minor projects, but major developers have not felt that rents in the Mission District could justify large scale projects.

Around inner-city station areas private residential redevelopment currently is not economically feasible, even if development regulations were less restrictive. This could change in the future. In the commercial areas, such as El Cerrito Plaza, or near the Mission-24th Street station, additional development might have occurred in the absence of BART-induced down-zoning. In both cases, however, prior zoning probably was not realistic for the station areas, and the new zoning more approximately reflects 1970s expectations of future land use patterns.

In conclusion, it seems that to date, lack of demand offers a better explanation of the lack of private redevelopment around inner-city BART stations than the down-zoning that occurred as a result of fear of potentially BART-induced development.

LAND USE

HYPOTHESIS 4. BART's effects on regional land use patterns are negligible, but local and corridor effects have occurred.

The Economics and Finance Project determined that BART has not affected the regional rate of growth, and the overall patterns of regional growth do not seem to have changed since BART. However, there have been BART-related land use changes, and the following sub-hypotheses present a synthesis of BART's land use effects.

Hypothesis 4-A. BART has had little regional effect on Bay Area land use patterns.

The LU & UD Project did not specifically investigate whether BART has affected development in the service area vis-a-vis development in the rest of the region.

Rather, the findings of the MTC Land Use Modelling (LUM) Project summarized below, were used as the basis for testing this hypothesis. The LUM Project was a macro-scale analysis of regional, service area, and corridor trends. These findings were:

1. The regional rate of population growth (including Santa Clara County) is slowing down, and the BART service area rate of growth is slowing down more rapidly.

2. Within the three-county BART service area, the rate of population growth does not appear to follow a consistent BART related pattern.

3. Regional employment continues to grow, with the greatest growth being concentrated outside the BART service area, particularly in Santa Clara County.

4. Within the BART service area, there has been no consistent and direct relationship between the presence of BART and change in employment, either total or BART sensitive employment, although there has been a significant increase in San Francisco employment since 1970.[26]

Based on these findings, it was concluded that BART had had little regional effect on Bay Area land use patterns.

Any effects that BART may have had were not discernible at the county-wide level of analysis. However, by not examining station areas versus non-station areas, failing to consider the amount of developable land for housing, and not differentiating on the basis of a maximum travel time, the LUM Project was not able to pick up the changes that have occurred.

The analyses carried out for this project indicated small BART effects, but on localized rather than regional patterns. These localized effects are summarized in the next hypothesis.

Hypothesis 4-B. **BART's localized effects on commercial and institutional uses have been greater than its effects on residential densities and location.**

Analysis of selected corridor and station area land use changes, statistical analysis of housing and employment changes, and key informant interviews indicate that this hypothesis cannot be rejected. Two types of land use changes

26. Metropolitan Transportation Commission, Land Use Modeling Project (Task Order 9) Stage I Findings and Stage II Implementation Plan (Berkeley: California, July 1977).

were examined: first, the total amount of development within 1,500 feet of stations (a measure of comfortable walking distance), and those additional developments known to be affected by BART that are beyond 1,500 feet of a station.

This study focused on effects at 18 selected BART stations classified according to the area served: downtown commercial and institutional (7 stations), urban mixed use (7 stations), and suburban mixed use (4 stations). Only the last category of station areas had significant amounts of vacant developable land in 1965; almost all new development that has occurred in the downtown and urban mixed use areas has been public or private redevelopment. Table 19 presents changes in total employment and occupied dwelling units between 1970 and 1975 for zones around the stations studied. The following area-by-area analysis highlights the commonalities and points out the differences between station areas.

Downtown Commercial and Institutional Station Areas

This classification includes the Embarcadero, Montgomery Street, Powell Street, and Civic Center BART stations in downtown San Francisco, and the Lake Merritt, 12th Street-City Center, and 19th Street BART stations in downtown Oakland.

San Francisco CBD Stations: Between 1970 and 1975, employment in the zones immediately adjacent to these stations increased substantially from 165,000 to 196,000 jobs, or an increase of 31,000 jobs, 72 percent of the net change in employment for the City and County of San Francisco. During the same period, there was a net increase of 93 housing units in the downtown area.

Since 1965, approximately 22.5 million square feet of new office space has been built or currently is under construction within 1,500 feet of the four downtown San Francisco BART stations, representing over 90 percent of new office space built in the CBD as a whole. Although BART's effects cannot be easily isolated from other influences in a San Francisco office space decision, key informants indicated that BART was an important determinant for approximately two million square feet, or about 10 percent of the new supply.

With the exception of several hotels, no other major new development occurred in downtown San Francisco within 1,500 feet of the BART stations between 1965 and 1977. Current zoning allows significantly more development in the downtown area, so there continues to be opportunities for further development adjacent to BART stations.

Oakland CBD Stations: From 1970 to 1975, employment increased by 4,800 persons or 11 percent in the downtown Oakland zones, which represented 21 percent of the net increase in Alameda County employment during that time period.

TABLE 19. CHANGE IN EMPLOYMENT AND OCCUPIED DWELLING UNITS, 1970 TO 1975: DEVELOPMENT PATTERNS STUDY AREAS

Downtown Commercial Areas	MTC Zones	Change in Employment	Change in Occupied Dwelling Units
San Francisco CBD	421-429	30,883	93
Oakland CBD	142-144	4,801	58
Urban Mixed Use Areas			
Richmond	118	121	-625
Fruitvale	159, 161	783	79
Coliseum	171-173	146	66
Hayward	185, 189	942	568
Mission	386, 387	758	85
Daly City	365	231	1,019
Suburban Mixed Use Areas			
Fremont	197, 204	720	798
Union City	193, 194	474	4,915
South Hayward	191, 192	138	420
Walnut Creek	98, 99	2,178	2,651

Source: Association of Bay Area Governments, Series 3 Projections, 1977.

In downtown Oakland approximately 2 million square feet of major new office space has been built since 1965. Roughly 1.5 million square feet was built within 1,500 feet of a BART station, and BART had an influence on 80 percent or 1.2 million square feet (Clorox, Wells Fargo, Blue Cross and World Savings). Other new uses in downtown Oakland since 1965 include the Laney College Campus which benefitted from use of BART construction cost "credits" toward the local share of redevelopment costs, the Oakland Museum, the BART headquarters building, and several multi-family housing developments. The zoning envelope in Oakland would permit substantially higher densities of commercial and residential space. There is, however, minimal vacant land and demand currently is insufficient to justify the costs associated with private redevelopment. The major remaining element of the City Center Redevelopment Project, the regional shopping center, indirectly benefitted from BART because the BART credits allowed the project to be expanded to the scale necessary for the shopping center. (The center, however, will not be built until Grove-Shafter freeway completion is guaranteed.)

Urban Mixed Use Areas

These station areas are typified by mixed commercial, industrial, and residential uses but with minimal vacant land available for development (with the exception of redevelopment projects). In this category are the Richmond, Fruitvale, Coliseum, Hayward, 16th Street-Mission, 24th Street-Mission, and Daly City BART stations.

Richmond: Only around this station has substantial development occurred within 1,500 feet between 1965 and 1977, virtually all of which was part of the redevelopment project partially made possible by BART credits. Between 1970 and 1975 there was a decrease of 625 occupied dwelling units in the station area zone, and an employment increase of 121. The major new project, the six-story Social Security Administration building (approximately 400,000 square feet) employing 2,000 persons was completed in 1975. This facility specifically located near the Richmond station to take advantage of BART access.

Other new uses in the redevelopment area include a three-story office building of approximately 45,000 square feet, and retail uses of about 60,000 square feet. A Kaiser Foundation hospital and clinic presently is being built in the station area. Its location decision also was affected by BART. A 173-unit subsidized housing project has been completed in the area, and additional housing is planned, but not committed. The final new use in the area affected by BART is the new AMTRAK station adjoining the BART station, designed to facilitate transfers.

The plans for the remaining vacant land in the redevelopment area call for a governmental office center with supportive retail uses. Adjacent areas are zoned for relatively high density housing, but demand still appears somewhat limited for market rate housing in the area.

Fruitvale: Between 1970 and 1975 there was an increase of 79 occupied dwelling units in the adjoining zones, and an employment increase of 783, an approximately

four percent increase. Development within 1,500 feet of the station has included 15 scattered, small multi-family buildings, several retail commercial buildings along East 14th Street, and two industrial buildings of approximately 13,000 square feet. None of these buildings are known to have been influenced by BART.

Apart from the commercially zoned strip along East 14th Street, the area east of the station is zoned high density residential, with up to 95 units per acre permitted. Current densities with mixed single family and multi-family housing are on the order of eight to 20 units per acre.

Adjoining the station and to the west the zoning is industrial although the current use is mixed single family and multi-family. As there is substantial vacant industrially zoned land in the East Bay and in Oakland, the area in all likelihood will remain in housing use. Several small multi-family buildings were built between 1965 and 1975.

Coliseum: Between 1970 and 1975, there was a minimal increase in both occupied dwelling units (66) and employees (146) in the traffic zones closest to the Coliseum station. With the exception of the Oakland-Alameda County Coliseum, which was under construction in 1965, there has been minimal new development within 1,500 feet of this station: three industrial buildings of approximately 14,000 square feet and two small commercial buildings. With the exception of some single family housing east of the parking lot, most of the area around the station is in industrial land use, with the Coliseum to the west connected by an overhead causeway. BART had no influence on these station area land use changes.

Hayward: While there was a six percent increase in employment in the zones around the Hayward BART station, minimal development is evident within 1,500 feet of the station. Review of land use changes between 1965 and 1977 shows nine scattered buildings of multi-family housing and two one-story commercial buildings of approximately 5,000 square feet. No BART influence was apparent.

16th-Mission and 24th-Mission Street: Within 1,500 feet of Mission Street stations, land use has not changed markedly within the past 13 years. Approximately 20 small commercial structures and seven institutional buildings (new school buildings) were built. There also were several scattered demolitions. Current zoning in the 16th Street and 24th Street station areas permits commercial uses along the Mission Street corridor and multi-family housing (three-story maximum) to the east and west. Higher density housing could be built on several scattered sites. No BART influence is apparent in the land use changes around either station.

Daly City: Although just over 1,000 additional housing units were built and occupied in the Daly City traffic zone adjoining the station between 1970 and 1975, less than 100 of those units were constructed within 1,500 feet of the station on scattered vacant sites, in buildings of five to 20 units. Land use

is primarily residential with variable quality. A Daly City redevelopment area incorporates commercial facilities several blocks from the station, but does not include the housing nearby the station. There was no other development within 1,500 feet of the station.

Approximately one to two miles south of the station, considerable residential and commercial construction has occurred, but this development also coincided with the opening of the Interstate 280 freeway linking the area to downtown San Francisco.

Suburban Mixed Use Areas

Typically around these stations are low density commercial and residential uses and significant amounts of vacant developable land within 1,500 feet. Analyzed in this category were the Fremont, Union City, South Hayward, and Walnut Creek BART stations.

Fremont: While there has been tremendous development of housing in Fremont between 1970 and 1975 (7,174 units), only 798 units were added in the two zones closest to the station, and none of the units were within 1,500 feet of the BART station.

Commercial development close by the station includes a small regional shopping center with two anchor tenants, Capwells and Montgomery Ward. Ward's indicated that BART did influence them to locate a store at that location (Young). Washington Hospital was expanded, and a new medical office building was constructed, but neither of these changes were related to BART, according to key informants. Several other small one-and two-story office buildings also were constructed within 1,500 feet of the station, developments unrelated to BART.

Outside the 1,500-foot limit, there is substantial institutional development: a City Hall, County Courthouse, and the California School for the Blind and Deaf. Locational decisions on these buildings may have been affected by BART, but they are beyond easy walking distance.

A 712-unit condominium project is proposed for a site approximately 1,000 feet east of the station, and is definitely BART related. The City has zoned the area for a minimum density of 50 units per acre and a maximum of 70, and this apparently has delayed any development to this time. Developers have been hesitant to build at that high a density in Fremont, where the majority of development has been single family homes or garden apartments. While the study of the housing industry concluded that BART has affected to some degree the rate and timing of housing construction in Fremont, to date this housing has not been built in the station area.

Union City: Between 1970 and 1975, there was considerable residential construction in the city, but this development (4,641 units in zones near the station) has

been beyond 1,500 feet. The exception is a tract of single family homes just at the 1,500 foot line. A small shopping center (150,000 square feet), a small office building of 5,000 square feet, and an industrial building of approximately 30,000 square feet have been other new uses in the station area. East of the station is a large area zoned for industrial use with site improvements, but otherwise undeveloped. One site is available for high density housing within the 1,500 foot-limit, and other sites are available for commercial and industrial uses. No BART impacts on development patterns are confirmed, but the presence of the station may have affected zoning for the shopping center.

South Hayward: Approximately 50 percent of the station area housing units added between 1970 and 1975 are located in a 195-unit mobile home complex. The project was influenced by BART; the developer wanted to build apartments on the site, but when the city allowed the density requested, the market was considered too weak for the rents that would have been required. A large multi-family housing complex also was constructed approximately 1,700 feet from the station.

Other new uses include scattered small commercial buildings (17 buildings) and one industrial building of 17,000 square feet. As of Spring 1978, there were apartments under construction southeast of the station, and a townhouse development just about 2,000 feet northwest of the station. Because of BART at grade right of way, some areas across the tracks from the station have relatively poor access. The only confirmed BART related project is the mobile home park, providing an exception to the general pattern of BART having had greater effects on commercial or institutional development decisions.

Walnut Creek: In the two zones closest to the station employment increased by 2,200 in the period 1970 to 1975 -- which represents 24 percent of the net increase in Contra Costa County employment between 1970 and 1975. There was also an increase of 2,651 occupied dwelling units, of which less than 200 were in 10 new multi-family buildings within 1,500 feet of the station. Besides nine new single family homes in scattered sites across the freeway from the station, substantial commercial office space and retail space was added in the station vicinity. The ten-story 135,000 square foot Walnut Creek Plaza building was built as general office space in anticipation of BART, and delays in the start of BART service may have slowed the occupancy of the building. Approximately 30 other commercial buildings were developed in the station area, of which a Cost Plus store (its site orientation was affected by BART) was one of the largest.

Several housing projects built in Walnut Creek beyond 1,500 feet of the station were affected by BART. Diablo Keys, a 788-unit apartment complex, was deliberately located near BART, and timed to coincide with BART opening. Stoneridge, a 339-unit apartment complex, also was located in response to BART. Finally, timing of development for Bancroft Village Townhouses was advanced one year as a result of BART.

In summary, the only station area uses known to be affected by BART were the decision to build the Walnut Creek Plaza Building and the specific siting of the Cost Plus. Large housing projects affected by BART all were built more than 1,500 feet from the station. BART apparently has been responsible for landowners north of the station ("the Golden Triangle") forming a cartel, thus restricting the supply of commercial land.

A 1977 study of clustering of townhouses around Concord line BART stations confirmed this lack of effect in station areas, concluding that BART had no impact on the location of higher density owner-occupied housing within the corridor.[27]

Several reasons explain why the majority of new development affected by BART in station areas consisted of commercial or institutional uses rather than housing. Possibly most important were the zoning incentives given to encourage commercial development in downtown San Francisco, Oakland, Richmond, and Walnut Creek (the incentives in Walnut Creek were eliminated after the Walnut Creek Plaza building was built). In contrast, eight station areas were downzoned (see Hypothesis 3-F), precluding substantial residential redevelopment. Although zoning in ten non-CBD station areas does allow higher density housing than currently exists in the surrounding neighborhoods (Bayfair, San Leandro, Concord, Pleasant Hill, Union City, Fremont, and to a lesser extent Walnut Creek, South Hayward, Richmond, and MacArthur), only Pleasant Hill, Union City, Fremont, and South Hayward have substantial vacant sites zoned for multi-family housing. The degree of intensification that is possible for residential redevelopment on currently occupied sites is not sufficient to justify the costs associated with acquisition and demolition of existing housing in comparison with construction on outlying vacant parcels. For example, in Walnut Creek, until very recently, land containing five units per acre and valued at approximately $500,000 per acre was zoned for a maximum of 20 units per acre. The intensification of only four times the units does not make private redevelopment economic. A differential land cost of $200,000 an acre over vacant land and a density of 20 units per acre would translate to a $80-90 per month rent differential, more than tenants would be willing to pay for station area housing. In contrast, redevelopment of a downtown San Francisco site for office use may involve an intensification of ten times and much higher rents per square foot in the new space. To date, no large-scale residential development has occurred on vacant land at the four stations where that is possible, although the Hub, a 712-unit condominium complex, is slated for a site adjacent to the Fremont station.

A second explanation of the type of development in station areas is that commercial uses affected by BART must be within walking distance of a station, housing

27. See Dennis Dingemans, Residential Subcentering and Urban Sprawl: The Location of Higher Density Owner Occupied Housing Around the Concord Line BART Stations (Berkeley: Institute of Urban and Regional Development, Working Paper 275, April 1977).

in auto-oriented suburban areas with station parking lots does not need to be close to BART to be influenced (Diablo Keys, Stoneridge). Analysis of the Household Survey indicated no difference in importance of BART in the location decision, whether the respondent was within a ten-minute walk or ten-minute drive of the station.

A number of other factors work against high density residential development in BART station vicinities: (1) Local opposition to non-suburban development patterns is precluding higher density development along the Concord line from Orinda outward. (2) Land speculators may be demanding unrealistically high prices for vacant parcels in proximity to BART stations, such that even intense development cannot be justified in terms of the developers' profit margins. (3) Regardless of land prices, a sufficient market may not exist for high density residential projects in suburban locations currently zoned for such development. Developers can offer greater amenity at lower density for the same price. (4) When nearly every household has at least one automobile, rapid transit can no longer have the nucleating effects that it did when people needed to live within walking distance of transit. Apartment dwellers in outlying areas are likely to have as high or higher ratio of cars to employed household members as occupants of single family homes. (5) Finally, outlying station areas themselves are not that attractive for residential development because of the ambiance created by the large BART parking lots and related traffic congestion.

Consistency of public policy and the federal A-95 review process greatly encourages new institutional uses in urban areas to be highly accessible by transit. In order to support ABAG's Regional Plan calling for a city-centered form of development, it is necessary for state, federal, and local government jurisdictions to give transit and BART access great consideration. Thus, decisions to locate the Social Security Administration facility in Richmond, the Laney College campus and federal ERDA offices in Oakland, a new Alameda County courthouse in Fremont, and new state and federal office space in San Francisco (State Compensation Insurance Fund on Market Street), and a new federal building (planned for Fourth Street near Market) were related to BART.

In summary, analysis of station area land use changes confirms that there has been substantially more BART related development in commercial and institutional uses than in residential uses.

Hypothesis 4-C. **BART has influenced development on prime agricultural land, environmentally sensitive land, and seismically unsafe land.**

A substantial proportion of development in areas influenced by BART has been on prime agricultural lands. Relatively less development influenced by BART has been on slopes and on seismically unsafe land.

A high proportion of residential development in Pittsburg-Antioch, Fremont-Union City, and Concord-Clayton has occurred on prime agricultural lands.

Most of the coastal plains and interior valleys in the Bay Area consist of prime agricultural soils; much of the lands that are not in this category are environmentally sensitive marshes or hillside areas with significant slope. None of the cities studied have made effective, long-term commitments to preservation of agriculture or adopted policies discouraging the use of prime agricultural lands for urbanization. While Williamson Act agricultural preserves can be used to alleviate urban potential taxation on agricultural lands, they have not been used to a great degree as the lower cost of development on the plains and the location of these areas at the fringe of urbanization have served to encourage their use for development. Although development on prime agricultural lands was encouraged or possibly hastened on specific sites by anticipation of BART service, development of these lands probably was inevitable in the absence of strong legislation regulating the urbanization of prime agricultural lands.

Development of Bay marshlands has not been influenced by BART. Hillside development has been permitted in Antioch, Pittsburg, Concord, and Walnut Creek, but not in Fremont or Union City. A small proportion of recent development in Pittsburg has involved cut-and-fill construction on hillsides. Antioch currently is restricting development on slopes of over 20 percent. In the 1970s Concord and Walnut Creek adopted hillside development policies and special permit requirements which are now required for hillside construction. Fremont hillsides are mostly in agricultural preserves and zoned open space, and less than 25 units have been built on hillsides in Union City. Therefore, with the possible exception of Pittsburg, hillside development currently is tightly controlled in those areas where BART has influenced urbanization.

Within the BART service area, many seismic hazard zones have been delineated along the San Andreas fault, the Hayward-Calveras fault, the Green Valley-Concord fault, and the Antioch fault.[28] The passage of the Alquist-Priolo Special Studies Zones Act of 1972 makes special engineering studies mandatory for structures (more than three single family homes) proposed to be built on a site subject to surface displacement from faulting. Although virtually the entire BART service area, if not most urbanized areas of California, is subject to potential damage from earthquakes, Alquist-Priolo zones represent the most vulnerable areas to surface movement. Such zones are approximately an eighth of a mile on either side of a fault, and are defined for Fremont, Union City, Hayward, Concord, and Antioch, among other Bay Area cities.

The Fremont BART station is the only BART station within an Alquist-Priolo zone and engineering studies are required for buildings in the area. Where the location of the fault is known, Fremont, by state law, has established a 50-foot wide belt within which no construction is permitted. A survey established that no city studied has regulations more restrictive than State requirements that

28. State of California, Division of Mines and Geology, Special Publication #42 - Fault Hazard Zones in California (Sacramento, California, January 1976).

control development within an Alquist-Priolo zone. In Antioch, Concord, and Fremont development has occurred within these zones. Most construction within the special studies zone, however, has been wood frame housing, the safest structure type in relation to seismic damage. Pittsburg does not have any identified faults of significance, and less than 25 units of housing have been built within the vicinity of the fault line in Union City.

Land use controls on slopes, land subject to flooding, and other environmentally sensitive lands are becoming more rigorous in the Bay Area, and the areas where development has been affected by BART are not particularly more sensitive than alternative areas. As such a high proportion of Bay Area land is considered prime agricultural and so many areas are subject to seismic damage, it seems inevitable that development would occur in such areas in the absence of further regulation. Thus, BART cannot be viewed as a major factor or even a catalyst in the decisions to develop such lands.

Hypothesis 4-D. **Redevelopment projects expanded as a result of BART have had an adverse effect on minority housing and employment opportunities.**

Although there has been some minority housing removed by redevelopment projects expanded as a result of BART, there is no evidence that on balance minorities were adversely affected by these projects. Where minority housing has been removed, most of it was in poor condition. Some replacement housing was constructed, and residents were relocated into better-quality housing under provisions of the federal Uniform Relocation Act. Additional employment and education benefits have resulted for minority residents.

The expansion of the Oakland City Center made possible by BART construction credits contained 550 units of housing that were removed to provide land for a regional shopping center. The housing was largely residential hotel space for elderly single men, mostly low income, but not all minority. Approximately 300 units of replacement low-cost housing were planned but have not been built to date, but all residents were relocated into appropriate housing.

Construction agreements and employer agreements with the Oakland Community Development Office (formerly the Redevelopment Agency) call for special efforts to employ minority Oakland residents, and to date on construction projects, there has been considerable minority hiring.[29]

29. Environmental Impact Planning Corporation, Oakland City Center Environmental Impact Report (Oakland: Oakland Redevelopment Agency, March 1973).

The Peralta College Redevelopment Project was greatly dependent on BART for local, non-cash credits. Again, households and industrial uses with minority occupants were relocated. The location of the new junior college in downtown Oakland has made it very accessible to minority families, and minority student enrollment is estimated at over 60 percent.

A considerable amount of minority housing was taken for redevelopment in downtown Richmond made possible by BART. To date, 173 units of new subsidized housing have been built in the area, the Social Security Center employing about 2,000 persons has been completed, and a Kaiser Foundation hospital and medical clinic is being constructed. Therefore, while there has apparently been a net reduction in housing in the station area to date as a result of redevelopment, employment opportunities and medical services have increased — a benefit for minorities (Burton, Fink, Woodward).

A proposed redevelopment project in the Mission District of San Francisco was defeated, and thus had no effect on minority groups, either negative or positive. BART had a minor effect on the boundaries of the Yerba Buena Convention Center Redevelopment Project, but the BART effect should neither help nor harm minority residents.

Redevelopment projects in Daly City, El Cerrito, and Hayward have been developed primarily with local funds under the California Redevelopment Act. In the latter two cases, the BART stations have been included within the project boundaries; their influence on the projects is a possible tax increment gain from potentially BART-related development. The El Cerrito project basically incorporates commercial revitalization and some housing rehabilitation (Smith). The Hayward project involves some residential rehabilitation, and new construction of housing, office space, and public facilities (Bush), and the Daly City project involves primarily commercial uses (Ciucci). None of these projects should have any particular effects on minority resident populations.

In conclusion, redevelopment projects in Oakland and Richmond that were expanded in their scope by BART involved the loss of some housing units to minority households. There are several factors alleviating this impact: first, provision of safe and sanitary replacement housing under the conditions imposed by the Uniform Relocation Act; second, construction of new housing units for low and moderate income households; and third, additional employment and educational opportunities for minority residents.

MINORITY EMPLOYMENT

HYPOTHESIS 5. BART-induced development and BART service have expanded employment opportunities for minorities.

As BART was designed primarily to bring suburban residents to centralized employment locations, it would not be expected to facilitate mobility within inner-city neighborhoods where many Bay Area minority households live.

However, there are several ways in which BART could serve to improve minority access to employment opportunities. First, to the degree that low income minority households are more transit dependent, BART could be important in improving access to jobs. Second, BART could provide transit dependent central city residents access to expanding employment areas that require a reverse commute. Third, although minority trips may not be well-served, BART influence on employers' location decisions could serve to benefit minorities. These hypotheses were tested as follows.

Hypothesis 5-A. **Public transit generally and BART specifically are more important criteria for accepting a job for minorities than for non-minorities.**

Limited evidence does suggest that transit and BART specifically are more important factors for job search and acceptance by minorities. There are several factors that define transit dependency, including income level, age (too young or old to drive), and disability. To the degree that income levels are lower for non-white households, it would be expected that they would be more transit-dependent. As BART widens the area served by public transit, it also widens the potential area of job search for transit-dependent individuals.

The availability of public transit is generally a minor reason for selecting a job; for example, of respondents to the MTC Workplace Survey, only 0.7 percent indicated that this was the primary reason for selecting a job. However, as Table 20 indicates, the response was significantly different between white and non-white respondents.

TABLE 20. AVAILABILITY OF TRANSIT AS THE PRIMARY REASON FOR ACCEPTING A JOB BY ETHNIC STATUS

Ethnic Group	Respondents	Percent Citing Transit Most Important[a]
White	5560	0.4[a]
Asian	971	1.6
Black	667	1.0
Spanish	505	1.4
Other	151	.7
Total	7854	.7

a. Significant difference at the .95 confidence level between white and minority respondents

Source: MTC Workplace Survey, 1977.

Evidence of BART's importance to non-white respondents is provided by analysis of responses to the 1976 BART Passenger Profile Survey. BART seems to have increased mobility of non-whites and particularly blacks more than for whites.[30] For example, 14.7 percent of black respondents who had not made the trip (mostly work trips) prior to use of BART indicated that they had no other means of transportation available for the trip. In comparison, only 8.1 percent of white respondents gave that as the reason for not making the trip. Comparable rates for Asian and Spanish surname respondents were 9.1 percent and 11.1 percent respectively. For those who made the trip prior to BART, BART seemed to be more effective in getting white respondents to switch from cars, with 16.8 percent of white respondents indicating they drove alone prior to BART, and 46 percent indicating they rode the bus. In comparison, only 9.4 percent of blacks drove, while 61.8 percent used the bus prior to switching to BART.

In conclusion, transit is more important in job selection for non-whites than whites, and BART seems to have increased mobility somewhat more for blacks.

Hypothesis 5-B. BART is having an effect on minority reverse commuting to employment opportunities.

Evidence on this hypothesis is mixed, but as there is little reverse commuting by minorities within the 88 zones of workplaces used on the MTC Workplace Survey, it can be concluded that BART is having no substantial effect on minority reverse commuting.

It has been stated by many observers that a primary cause of minority unemployment is that the growth of employment in urban areas has been in suburban locations while many minority households remain in the inner-city without automobiles. If this is so, BART should improve access to suburban employment centers by having better reverse commute service than alternative modes of transit (BART trains run in the reverse commute direction at the same frequency as peak direction, while many commuter buses remain unused in San Francisco during the day).

As was indicated in Table 19 (see Hypothesis 4-B), the greatest increase in employment in zones adjacent to BART between 1970 and 1975 has been in downtown San Francisco, and secondarily in downtown Oakland and Walnut Creek. Therefore, it is not surprising that, according to results of the MTC Workplace Survey, only 4.9 percent of work trips from the San Francisco-Daly City BART corridor are to workplaces in the East Bay. For minority respondents in San Francisco, only 3.5 percent of work trips involve that reverse commute trip.

30. Interviews of retail store managers indicated that five of 16 believed that applications for employment from minorities had increased since BART began service. All of these stores were located in close proximity to BART stations. (See the John Blayney Associates/David M. Dornbusch & Co., Inc., Study of Retail Sales and Services).

As Table 21 below indicates, although a small percentage of minority trips were reverse commutes from Oakland, BART was a somewhat more frequent mode for black and Spanish heritage respondents than white or Asian travelling between residences in the Oakland corridor and workplaces along the Fremont corridor. As the total number of BART trips from Oakland to the Fremont corridor is under 1,500, there are less than 1,000 Oakland minority residents using BART to commute to work along the Fremont corridor. Therefore, any BART impact on employment opportunities has been minor.

TABLE 21. MODE OF TRANSPORTATION BY ETHNIC STATUS: WORK TRIPS FROM OAKLAND TO THE FREMONT CORRIDOR

	Ethnic Status			
Mode	White	Black	Spanish	Asian
BART	7.6	19.6	20.8	0.0
Other Transit	3.6	6.6	22.0	21.3
Auto	88.8	69.4	50.2	78.7

Source: MTC Workplace Survey, 1977.

Key informant interviews were conducted among persons involved in minority job placement. While one key informant felt that BART had been a factor in encouraging minority persons in San Francisco to seek and accept employment in Oakland (Del Carlo), other informants felt that BART had not been useful to inner-city workers seeking employment in suburban areas (Hicks, Lopez, Miranda, Robinson). Many of the larger manufacturing employers in southern Alameda County are not within walking distance of BART, and/or have shifts that make it impossible for workers to use BART. Although there has been expansion of blue collar employment in this area, the hours and locations have made it difficult for transit dependent minority workers to use BART to get to these areas.

The transbay reverse commute phenomenon was analyzed by the TSTB Project to determine whether BART has improved accessibility of low income and minority residents of San Francisco to job opportunities in East Bay industrial areas. Comparing socio-economic characteristics of transbay reverse commute riders and automobile users, the TSTB Project found that of 2,300 BART trips, 21

percent were by non-whites and 25 percent by people with family incomes below $10,000. In comparison, 17 percent of 15,600 auto trips were by non-whites, and 18 percent had incomes below $10,000. While 21 percent of the BART reverse transbay commute trips were by non-whites, only 8 percent of peak direction transbay trips were by non-whites, suggesting that BART proportionally serves more non-white households in the reverse commute than for transbay travel as a whole.[31] While no employment data is available for sub-areas and ethnic status, it does seem that BART may have extended accessibility for some transportation disadvantaged non-whites. However, the magnitude of any such benefit has been small, and not a major impact of BART.

Hypothesis 5-C. Although work trips from central city minority areas are not well served by BART, BART has had significant indirect effects on minority employment opportunities.

Interviews of key informants for the study of employers' location decisions indicated that BART influenced several employers to remain or locate in central cities. The central city employment locations provide better access to jobs for inner-city residents, including minorities, than a suburban location would, even if minority workers primarily use buses or automobiles.

Although few employers specifically located in a central city area to attract a minority workforce, situations in which an employer was influenced by BART to locate or remain in a downtown area served to increase the likelihood for increased minority employment in comparison with a less central location. Several employers in Oakland (ERDA, Clorox, Blue Cross) and the Social Security Administration in Richmond cited BART as somewhat important to their decisions to locate where they did. This would be particularly true for Blue Cross, where a spokesman indicated that the firm considered moving to San Ramon, and would have done so if Oakland did not have the advantage of BART (Zwolenkiewiez). ERDA (Vergari) mentioned access for minority employees as a reason for locating at Oakland City Center. The Social Security Administration move to Richmond, influenced by BART, provided a major source of employment for Richmond residents, many of whom are lower income blacks.[32] Also, several downtown retail employers cited that applications for employment from minorities increased

31. Jefferson Associates, Special Groups Mobility Analysis (Berkeley: BART Impact Program Transportation Systems and Travel Behavior Project, August 1975), p. II-8.

32. Currently, 65 percent of SSA employees are minority, including 40 percent black. Since the move to Richmond, the proportion of employees living in Contra Costa County increased from 15 percent to 35 percent, so either these were new local employees or many employees chose to move to the area.

after BART initiated service.[33] Therefore, it seems that BART's greatest benefit for minority employment may be the degree to which BART convinced management to remain or locate in Oakland, Richmond, or San Francisco rather than some suburban location which would have been not as accessible to large minority populations.

The key informant interviews indicated several reasons why BART has not been more effective in improving minority group mobility to and from jobs. First, the largest increases in employment opportunities for minorities have been in downtown San Francisco and Oakland, but as a result of affirmative action programs, not BART. As minority groups tend to live closer to these areas, they are more likely to rely on local transit. Informants stated that the general trend was for minority households to live closer to employment centers. There is considerable statistical evidence of this based on the Workplace Survey and several potential explanations. Minority households are more likely to be renters, and renters are more mobile in residential patterns and move to be close to employment.[34] Second, considerations such as neighborhood and school quality are more important for white households with incomes that allow a trade-off in commute times and these factors.[35] Most minority households do not have incomes that allow large commute costs. Third, historical housing discrimination in suburban communities has tended to limit potential residential mobility of minority households. Thus, although there have been increases in suburbanization among minorities, the rate of minority suburbanization varies tremendously between communities, and is also a relatively recent phenomenon.

In conclusion, BART has improved mobility for some minority households, but has not substantially improved accessibility to suburban employment locations for inner-city residents. Most suburban employment centers are not easily accessible by BART, and many have shift laws that have made BART use infeasible as well. An indirect benefit may accrue to inner-city households (including minorities) as BART has encouraged centralized employment to a greater degree than the NBA would have.[36]

33. See John Blayney Associates/David M. Dornbusch & Co., Inc., Study of Retail Sales, p. 28.

34. H. James Brown, "Changes in Workplace and Residential Location," Journal of the American Institute of Planners, January 1975, p. 37.

35. See John Blayney Associates/David M. Dornbusch & Co., Inc., Households' Location Decisions, p. 21.

36. For more information on BART's effects on minorities, see Jefferson Associates, Minority Transportation Needs Assessment Project (Berkeley: Metropolitan Transportation Commission, 1977); Jefferson Associates, Three Community Case Studies (Berkeley: BART Impact Program Institutions and Lifestyles Project, August 1977); and Urban Dynamics Associates, BART's Implications for the Transportation Disadvantaged (Berkeley: BART Impact Program), March 1978.

5. CONCLUSIONS AND POLICY IMPLICATIONS

The conclusion of this study is that BART seems to have influenced the distribution of development within the BART corridors and in some station areas, but not to the degree anticipated by the system's planners. More specifically, evidence was found supporting the following findings:

- BART has not increased three-county BART service area growth at the expense of other Bay Area counties. Population and employment continue to grow at a faster rate in the rest of the region and, most specifically, in Santa Clara County. Population growth inside the service area was less than one percent between 1970 and 1975, while regional population outside the service area increased by nine percent.

- Within the four corridors served, BART has affected both employment and residential location decisions, but effects on employment location are more apparent. While not all development was BART-related, 51 percent of the employment increase in the 239 zone greater BART service area occurred in 31 zones surrounding 18 stations. In comparison, 14 percent of the growth in service area housing units was in these 31 zones.

- BART's effects within station areas have been greater on employment location decisions than residential location decisions. Little new housing has been built within 1,500 feet of BART stations, BART-related or otherwise, while there has been a significant amount of new office space specifically constructed to take advantage of proximity to BART.

- BART-related employment growth in station areas has been greater in the older central cities of San Francisco and Oakland (the centers) than in suburban areas such as Walnut Creek, Hayward, or Fremont (sub-centers). BART, along with other development incentives (zoning and public redevelopment), influenced the location of over three million square feet of new office space in San Francisco and Oakland, affecting job opportunities for over 12,000 persons. The only other major office buildings located in response to BART were in Richmond (400,000 square foot Social Security Administration Center), Berkeley (135,000 square foot Great Western building), and Walnut Creek (the 135,000 square foot Walnut Creek Plaza building).

- BART rarely influences a household's decision to move, but has affected the locational decisions of some service area households once the decision to move has been made. This primarily affects moves to or within suburban communities made by households with a member employed in downtown San Francisco or Oakland. BART has not markedly affected decisions to move from inner city areas to suburban communities. A small proportion of those influenced made such moves, and BART was no more important to these movers than it was to movers within suburban communities.

- In effects on the supply of housing, BART influenced the timing and location of several suburban multi-family projects in the Concord and Fremont corridors (i.e., such as the Diablo Keys complex in Walnut Creek), and a few scattered single family projects in outlying suburban areas, such as Fremont and the Pittsburg-Antioch area.

- Black suburban population growth is occurring in equal, if not greater, proportions than white growth in communities served primarily by the BART Richmond and Fremont lines. It is not clear whether BART is a more important factor in black suburbanization, but blacks do have a higher central city workplace orientation in Fremont — the one community where this was studied.

- BART has not significantly improved inner-city minority access to employment opportunities. BART does provide indirect benefits to central-city minority populations by being an influence on employers' decisions to stay in central-city locations rather than move to locations less accessible to minority populations.

BART's impacts on development patterns have been less than anticipated for several reasons. First, BART does not yet offer full, seven-day service, and has suffered from poor service quality and adverse publicity. Second, patronage has been substantially lower than projected; a daily BART patronage of 220,000 trips anticipated under full service conditions would have somewhat greater land use impacts. At current patronage levels, BART is used on less than three percent of all service area trips, and only about five percent of service area work trips. A longer period of service is necessary before definitive conclusions can be drawn. Finally, the low intensity commercial and residential districts adjacent to many suburban stations were not easily converted to the higher intensity clustering anticipated to form suburban sub-centers.

In many cases, local public policy did not reinforce or encourage BART impacts; some development opportunities were intentionally blocked, while others were not pursued aggressively. Fragmented local decision making perpetuates existing urbanization patterns and is not sensitive to the potential benefits of transit-oriented development.

In recent years, a depressed multi-family housing market has not provided much support for any high density station area housing proposals. The aggregate trend has been toward more single family dwellings built on vacant land, the locations of which BART could not greatly effect.

The development of large park-and-ride lots, as well as initial route and station location decisions that were not conducive to clustered development, contributed to the lack of land use changes in suburban areas. In several station areas with possible potential for private redevelopment, such as North Berkeley, Rockridge, and Orinda, zoning regulations were changed to restrict development or never would have permitted intense transit-oriented development. At other stations

around which high density development was permitted, market demand was weak and little redevelopment occurred. Without higher density zoning bonuses near the stations, the costs of redevelopment in station areas exceed the costs of building on vacant land. While some households moving into Walnut Creek expressed a willingness to pay more for a site near BART, and developers expressed a willingness to pay an additional $500 to $5,000 a residential unit for land near BART stations, the differential cost of land acquisition and development has been greater than what the developers have been willing to pay, given the difficulties of land assembly and general station area environments.

In conclusion, these findings are not particularly surprising because of the relatively small impact BART has had on regional accessibility and mobility. It may be unreasonable to expect BART to have a greater impact on land use until competitive modes become more congested and BART is able to offer a significant savings in travel time and cost. Further, the limited opportunities for housing development in the BART service area provided a real constraint on BART's ability to affect land use and development decisions.

NO-BART ALTERNATIVE

In terms of the No-BART Alternative -- the MTC-defined regional bus transit system that might have existed in the absence of BART (minor improvements to the 1971 transportation system) — BART's effects on development patterns have been greater for several reasons. First, BART was a visible public commitment to the central cities that encouraged employers to remain or locate in San Francisco, Oakland, and Richmond. To the extent that BART increases capacity in the Bay Bridge corridor more than the NBA, BART also will have a greater influence on downtown San Francisco employers' and workers' locational decisions. Third, BART provided a large portion of local credits for redevelopment projects in Oakland and Richmond, thereby expanding the City Center project and providing a site for the Social Security Administration in Richmond. Fourth, BART has had more effect than the NBA would on locational decisions of hedgers, those interested in the use of BART who do not use BART at present. Finally, BART amenities, such as plazas and direct entrances from offices and stores in San Francisco and Oakland, are unquantifiable factors that distinguish it from the NBA.

POLICY IMPLICATIONS

A better understanding of how BART, and possibly rail transit anywhere, affects development patterns can aid in formulating land use and urban development policy. However, it is important that the differences between the expectations and reality of BART's impacts be noted, and not just BART's effects vis-a-vis the No-BART Alternative.

A transit improvement such as BART will not particularly affect the rate of urban development within the service area. In the absence of strong economic demand in an area, a transit station will not cause development. A station may serve to shift the demands for office space or housing within a community and even a metropolitan area if those demands exist and incentives are offered for station area development.

BART will not change development patterns without accompanying and consistent policies from all levels of government. In order to have the effects anticipated, it would be necessary to institute much more supportive zoning and land use incentives and controls than has been the case in most communities served by BART. Density bonuses near stations, such as higher floor area ratios allowed near downtown San Francisco stations, or Fremont's minimum density residential zoning district adjoining the station, offer examples of necessary steps to encourage densities supportive of substantial pedestrian usages of stations.

Development is less attracted to sites near transit stations that primarily rely on park-and-ride patronage than it is to downtown station areas. Without coordinated and careful joint use planning, the size of the parking lots and traffic impacts create undesirable residential environments around park-and-ride stations. Successful joint use residential projects in station areas must consider noise and traffic impacts of the station, and be designed with these problems in mind.

Stations primarily devoted to park-and-ride patronage possibly should be located in undeveloped areas where large amounts of land could be assembled at costs lower than that associated with acquisition and relocation of existing uses in built-up suburban neighborhoods. This also would minimize adverse effects of any overflow parking and increased traffic on nearby neighborhoods.

Pedestrian stations located in urban central business districts will serve to reinforce these areas more effectively than park-and-ride stations will reinforce suburban areas. The highly visible public commitment to the central cities is important for encouraging private capital investment in these areas. The majority of new suburban development occurs on vacant land away from station areas, and suburban station area redevelopment awaits demand for intensification.

With current corridor land use policies BART will have more effect on employment location than housing, by allowing a greater flow of traffic through constrained corridors into employment centers, such as across the Bay into San Francisco and through the Caldecott Tunnel. With the large park-and-ride parking lots, suburban housing does not need to be near the station to be affected by BART, while office space at destination stations must be within walking distance as few persons are willing to transfer modes near their destination.

BART will not directly improve accessibility for minority populations in central cities to the degree it helps suburban commuters to central cities. Indirectly it will aid central city households to the degree that it encourages centralization or slows the decentralization of employment, therefore maintaining employment in areas accessible by inner-city minority populations. Suburban employment locations are too decentralized to be served effectively by BART.

The limited land use impacts experienced in the Bay Area so far suggest that the case for rail rapid transit based on its urban form-making potential cannot be made easily. Planners and decision makers contemplating similar fixed rail rapid transit investments would be well-advised to re-evaluate their expectations for short-term, transit-induced changes in light of the findings of this project. The passage of time and improvements in service quality may bring more dramatic land use impacts. Study of future effects should be pursued with a long-term monitoring project.

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APPENDIX A. KEY INFORMANTS INTERVIEWED

Informants	Affiliation	Area
Employment		
Juanita Del Carlo	Executive Director-Mission Hiring Hall	Mission District
Patricia Hicks	CETA Program — Bay Area Urban League	San Francisco
Danny Miranda	Apprenticeship Opportunities Foundation	San Francisco
Charles Robinson	California Economic Development Department	San Francisco
Evelyn Vann	California Economic Development Department	Mission District
Juan Lopez	Director of Manpower — City of Oakland	Oakland
Stephanie Swanigan	Oakland Citizens Committee for Urban Renewal	Oakland
Paul Varacelli	Executive Secretary — United Public Employees Local 390	Oakland
Gary Fink	Chief of Personnel, Social Security Administration	Richmond
Housing and Redevelopment		
June McEvoy	Padilla Realty	Mission District
Rai Okamoto	Director — San Francisco Planning Department	Mission District
Lee Soto	Executive Director — Arriba Juntos	Mission District
Patricia Salinas	Planner — San Francisco Planning Department	Mission District
David Hoard	Director — Community Development Department	Oakland

Informants	Affiliation	Area
Housing and Redevelopment (continued)		
Norman Lind	Director -- Planning Department	Oakland
L. Jother	East Oakland Fruitvale Planning Council	Oakland
Clyde Brewster	Foothill Merchants Association	Oakland
Dene Ogden	Real Estate Appraiser	Oakland
Ted Burton	Housing Director	Richmond
Tom Hirschfeld/Al Jones	Redevelopment Agency	Richmond
Jean Smith	Planning Director	El Cerrito
John Bush	Redevelopment Administrator	Hayward
Monty Florence	Civic Center Realty	Hayward
Don Ciucci	Planner — Redevelopment Agency	Daly City
Allen Rose	Rose Realty	Daly City

APPENDIX B. KEY INFORMANT INTERVIEW

EMPLOYMENT QUESTIONNAIRE (HUMAN RESOURCES CORPORATION)

1. Since 1970 are minorities accepting jobs in different locations in the Bay Area?

   A. What places (cities or other locational designation)?

   B. What minorities (Black, Latino/Hispanic, Japanese, Chinese, Filipino, other)?

   C. Has BART been a factor in minorities working in these new locations? COMMENT.

2. Within the service area of BART (Alameda, Contra Costa and San Francisco Counties), in what places have employment opportunities for minorities increased?

   A. What places (cities or other locational designations)?

   B. What types of jobs?

   C. What minorities (Black, Latino/Hispanic, Japanese, Chinese, Filipino, other)?

   D. Has BART been a factor in the increased opportunities for minorities in these places? COMMENT.

3. Are there types of jobs in the three-county BART service area available to minorities now that weren't in 1970?

   A. What types of jobs?

   B. What minorities (Black, Latino/Hispanic, Japanese, Chinese, Filipino, other)?

   C. Has BART been a factor in the opening up of these jobs? COMMENT.

4. In places where minorities worked in 1970, has there been an increase in minority employment?

   A. What places (cities or other locational designations)?

   B. What minorities (Black, Latino/Hispanic, Japanese, Chinese, Filipino, other)?

   C. Has BART been a factor in the employment increases? COMMENT.

5. Has BART reduced the use of the automobile as a mode of transportation for minority workers? COMMENT.

   A. For what minorities (Black, Latino/Hispanic, Japanese, Chinese, Filipino, other)?

6. In your opinion has there been any evidence that BART has increased employment opportunities for minorities by improving access to places? COMMENT.

7. IF BART HAS NOT AFFECTED THE OPENING OF NEW JOB OPPORTUNITIES FOR MINORITIES, what do you think is the reason? COMMENT.

   A. Location of places of employment?

   B. Cost of transportation on BART?

   C. Preference for?

      _____ Bus

      _____ Automobile

   D. Living near place of employment?

8. IF BART HAS AFFECTED THE OPENING OF NEW JOB OPPORTUNITIES FOR MINORITIES, to what has this been due?

   A. New places of employment?

   B. New transportation to old places of employment?

APPENDIX C. KEY INFORMANT INTERVIEW

HOUSING AND REDEVELOPMENT QUESTIONNAIRE (HUMAN RESOURCES CORPORATION)

1. Since 1970 has the vacancy rate for residential rental units in . . . (area about which interviewing)

_____ increased
_____ decreased
_____ not changed

COMMENT ON EXTENT OF CHANGE.

2. Since 1970 has the sale of residential property in . . .

_____ increased
_____ decreased
_____ not changed

COMMENT ON EXTENT OF CHANGE.

3. Since 1970 are the people coming into . . .

A. From--

_____ (1) Other parts of the county?
_____ (2) Other Bay Area Counties?
_____ (3) Outside of the Bay Area?

B. Income level--

_____ (1) With household incomes under $10,000
_____ (2) With household incomes of $10,000 under $15,000
_____ (3) With household incomes of $15,000 under $20,000
_____ (4) With household incomes of $20,000 or more

C. Minorities--
_____ (1) Blacks
_____ (2) Latinos/Hispanics
_____ (3) Asians and Pacific Islanders (Chinese, Japanese, Filipino)
_____ (4) Other _____

D. Households with--

_____ (1) Adults only
_____ (2) Adults with children

4. Why do people seek housing in this area? What do they want? What do they like? COMMENT. (Continue on back, if necessary.)

5. Since 1970 what people are moving out of the area . . .

A. To--

_____ (1) Other parts of the county?
_____ (2) Other Bay Area counties?
_____ (3) Outside of the Bay Area?

B. Income level--

_____ (1) With household incomes under $10,000
_____ (2) With household incomes of $10,000 under $15,000
_____ (3) With household incomes of $15,000 under $20,000
_____ (4) With household incomes of $20,000 or more

C. Minorities--

_____ (1) Blacks
_____ (2) Latinos/Hispanics
_____ (3) Asians and Pacific Islanders (Chinese, Japanese, Filipino)

D. Households with--

_____ (1) Adults only
_____ (2) Adults with children

6. Why have people moved out of the area? What are they seeking? COMMENT.

7. Compared to other (cities, counties) nearby, for this area. . .

A. Are rents:

_____ higher
_____ lower
_____ not different

COMMENT ON DIFFERENCE:
COMPARED WITH _____

B. Are residential sale prices:

_____ higher
_____ lower
_____ not different

COMMENT ON DIFFERENCE:
COMPARED WITH _____

8. Since 1970 has private residential development in the area . . .

_____ increased
_____ decreased
_____ not changed

COMMENT ON EXTENT OF CHANGE:

9. Have local zoning requirements deterred or encouraged private developers? In what way?

10. Since 1970, what other factors have affected private residential development in the area . . .

Encouraged	Deterred

11. Currently, for what kind of housing is there a shortage in the area . . .

12. Who that seeks housing is not finding it . . .

    A. Income level? COMMENT.

    B. Minority? COMMENT.

    C. Because of household composition? COMMENT

13. What kind of housing is available within the area . . . for which there is insufficient demand? What accounts for the lack of demand? COMMENT.

IF THERE HAS BEEN URBAN REDEVELOPMENT IN THE COMMUNITY:

14. Did urban redevelopment add resources to benefit the community, such as:

    A. New large employer _____

    B. New health facility _____

    C. New schools, college _____

    D. New businesses _____

    E. Other _____

15. What segments of the population benefitted from the new resources? COMMENT.

    A. Income level--

    B. Minorities--

APPENDIX D. REGRESSION EQUATIONS, VARIABLES, AND CORRELATION MATRICES

The basic data source for the regression analyses was the MTC-ABAG Projective Land Use Model (PLUM) QUEST file, a source of population, housing, land, and employment data collected for 440 traffic analysis zones (2-4 census tracts) in the Bay Area. For the models described here, data from only 239 zones were used, which include Alameda, Contra Costa, San Francisco, and Northern San Mateo Counties, representing the BART primary service area. The data were available for 1970 and 1975, were developed by MTC and ABAG using census and other sources, and were verified with local agencies. Below are listed the PLUM variables, those variables computed from PLUM variables, as well as specially constructed variables and their definitions. Other variables, such as network data and BART patronage, were gathered from other sources.

Variable List

Variable	Definition
1. ODWU 70	Occupied dwelling units, 1970
2. ODWU 75	Occupied dwelling units, 1975
3. RESP 70	Resident population, 1970
4. RESP 75	Resident population, 1975
5. ERES 70	Employed residents, 1970
6. ERES 75	Employed residents, 1975
7. RETT 70	Retail trade employment, 1970
8. RETT 75	Retail trade employment, 1975
9. BUSS 70	Professional and business service employment, 1970
10. BUSS 75	Professional and business service employment, 1975
11. RETS 70	Retail service employment, 1970
12. RETS 75	Retail service employment, 1975
*13. OPTI	Other principal transportation improvements
*14. DZB	Distance zone to BART
+15. DL 70	Developed land (BASA + LSRA + RESA + SHFW)
+16. DDL 70	Developed and developable land (TOTA - UNUA)
+17. RDL 70	Relative availability of developable land (DL 70/DDL 70)
*18. CBD	Proximity to nearest CBD
*19. BAC	Before/after percent change in BART accessibility
20. MNIN 70	Mean income, 1970
21. MNIN 75	Mean income, 1975
+22. CBDA	CBD attraction (TEMP 70/CBD)
+23. CBDI	Inverse of distance to CBD (1/CBD)
+24. TEMP 70	Total Employment, 1970 (BASE + LSRE)
+25. TEMP 75	Total Employment, 1975 (BASE + LSRE)
+26. CODWU	Change in occupied dwelling units (ODWU 75 - ODWU 70)
+27. PCODWU	Percent change in occupied dwelling units (CODWU * 100/ODWU 70)
+28. CRESP	Change in residential population (RESP 75 - RESP 70)

Variable	Definition
+29. PCRESP	Percent change in residential population (CRESP * 100/RESP 70)
+30. CERES	Change in employed residents (ERES 75 - ERES 70)
+31. PCERES	Percent change in employed residents (CERES * 100/ERES 70)
+32. CRETT	Change in retail trade employment (RETT 75 - RETT 70)
+33. PCRETT	Percent change in retail trade employment (CRETT * 100/RETT 70)
+34. CRETS	Change in retail service employment (RETS 75 - RETS 70)
+35. PCRETS	Percent change in retail service employment (CRETS * 100/RETS 70)
+36. CBUSS	Change in professional and business service employment (BUSS 75 - BUSS 70)
+37. PCBUSS	Percent change in professional and business service employment (CBUSS * 100/RETS 70)
+38. CMNIN	Change in mean income (MNIN 75 - MNIN 70)
+39. PCMNIN	Percent change in mean income (CMNIN * 100/MNIN 70)
40. FSGT 70	Federal and State Government employment, 1970
41. FSGT 75	Federal and State Government employment, 1975
+42. CFSGT	Change in Federal and State Government employment (FSGT 75 - FSGT 70)
+43. PCFSGT	Percent change in Federal and State Government employment (CFSGT * 100/FSGT 70)
44. FIBI 70	Other service employment, 1970 (FINS 70 + SVC1 70 + SVC2 70)
45. FIBI 75	Other service employment, 1975 (FINS 75 + SVC1 75 + SVC2 75)
+46. CFIBI	Change in other service employment (FIBI 75 - FIBI 70)
+47. PCFIBI	Percent change in other service employment (CFIBI * 100/FIBI 70)
*48. DZBI	Inverse of distance, zone to CBD (1/DZB)
49. ACCBHU	BART Network/Highway Travel Time/Unweighted to zone 422
50. ACCBHW[1]	BART Network/Highway Travel Time/Weighted to zone 422
51. ACCBTU	BART Network/Transit Travel Time/Unweighted to zone 422
52. ACCBTW[2]	BART Network/Transit Travel Time/Weighted to zone 422
53. ACCNTU	NBA Network/Transit Travel Time/Unweighted to zone 422
54. ACCNTW[3]	NBA Network/Transit Travel Time/Weighted to zone 422
55. HWT	Highway (peak hour) trips to SF CBD (zone 422)
56. TRT	Transit (peak hour) trips to SF CBD (zone 422)
57. BAM	BART entrances -- AM peak, closest station
58. BPM	BART entrances -- PM peak, closest station
*59. DZBR	(DZBI * BAM)
*60. DZBE	(DZBI * BPM)

* Constructed variables.
\+ Computed variables.
1. ACCBHW = 1/ACCBHU * HWT
2. ACCBTW = 1/ACCBTU * TRT
3. ACCNTW = 1/ACCNTU * TRT

Equations and Correlation Matrices

The findings of regression equations of BART's influence on population, employment, and housing were discussed in hypotheses 1-A, 2-A and 3-B; the equations along with the correlation matrices for their coefficients are presented below. These matrices indicate the degree to which multicollinearity would be expected to have influenced the parameter estimates. All of the estimated equations as a whole were significant at the .95 confidence level. However, the BART variable (influence) was not always significant.

1. Population. The equation for the net change in population is:

$$\begin{array}{lccccc} \text{CRESP} = & 8.22\text{ACCBHW} + & .151\ \text{DZBR} - & 3687.2\text{RDL70} + & 218.5\text{CBDI} & \\ \text{(t-statistic)} & (2.50^*) & (1.22) \quad (-7.17^*) & & (1.62) & \\ & - 18.27\text{ACCNTW} + & 2655.9 & & & \\ & (-.88) & (6.68^*) & & & \end{array} \qquad \text{(D-1)}$$

where
- CRESP = change in zone residential population, 1970-75.
- ACCBHW = measure of highway influence (highway travel time multiplied by 1976 peak hour highway trips to downtown San Francisco (zone 422)).
- ACCNTW = Measure of other transit influence, 1976.
- DZBR = Measure of BART influence (inverse of distance to BART station multiplied by AM peak station entrance count, 1976).
- RDL70 = Proportion of developable land that was developed in 1970.
- CBDI = Inverse of distance to the closest Central Business District.

and
- n = 239
- R^2 = .22 Durbin-Watson Statistic = 1.66
- $F_{(5,233)}$ = 13.19*

*Asterisk indicates significance at the .95 confidence level.

The relative availability of developable land, the constant, and the highway influence are significant determinants of the change in population; although the BART influence has the expected sign, it is not significant. As the correlation matrix below indicates, there is no problem with multicollinearity.

CORRELATION MATRIX OF COEFFICIENTS
(Dependent Variable = CRESP)

	ACCBHW	ACCNTW	DZBR	RDL70	CBDI
ACCBHW	1.00	.488	-.071	-.051	.180
ACCNTW		1.00	.089	.321	-.187
DZBR			1.00	.071	.181
RDL70				1.00	.189
CBDI					1.00

2. Percent change in population. The equation for the percent change in population is as follows:

$$\begin{array}{lll} \text{PCRESP} & = & .074\text{ACCBHW} + .001\text{DZBR} - 42.5\ \text{RDL70} + 5.91\text{CBDI} \\ \text{(t-statistic)} & & (2.02^*) \qquad (.70) \qquad (-7.11^*) \qquad (3.76^*) \\ & & - .16\text{ACCNTW} + 32.45 \\ & & (-.665) \qquad (7.01^*) \end{array} \qquad \text{(D-2)}$$

where PCRESP = Percent change in zone residential population, 1970-75 and the same set of independent variables as in equation D-1

and $n = 239$

$R^2 = .23$ Durbin-Watson Statistic = 1.48

$F_{(5,233)} = 14.11$

*Asterisk indicates significance at the .95 confidence level.

In this equation, the relative availability of land is the most significant variable, but distance to the closest CBD, the highway influence, and the constant are also significant. The correlation matrix indicates no multicollinearity.

CORRELATION MATRIX OF COEFFICIENTS
(Dependent Variable = PCRESP)

	ACCBHW	ACCNTW	DZBR	RDL70	CBDI
ACCBHW	1.00	.488	0*	-.051	.180
ACCNTW		1.00	.086	.322	-.187
DZBR			1.00	.072	.181
RDL70				1.00	.189
CBDI					1.00

*Number is 0 in var-cov matrix, probably due to too few spaces allotted in program.

3. Employed residents. The equation for the net change in employed residents is as follows:

$$\begin{array}{lll} \text{CERES} & = & 4.35\text{ACCBHW} + .105\text{DZBR} - 1237.6\text{RDL70} + 16.1\text{CBDI} \\ \text{(t-statistic)} & & (3.14^*) \quad (1.95) \quad (-5.51^*) \quad (.27) \\ & & + 6.37\text{ACCNTW} + 1155.3 \\ & & (.70) \quad (6.65^*) \end{array} \qquad \text{(D-3)}$$

where CERES = change in zone employed residents, 1970-75, and the same set of independent variables specified for equation D-1.

and $n = 239$

$R^2 = .16$

$F_{(5,233)} = 8.89^*$

Durbin-Watson Statistic = 1.64

*Asterisk indicates significance at the .95 coefficient level.

The availability of land, the highway influence, and the constant are significant in this equation. The BART influence is positive but not significant, with an F level of .053. There is no multicollinearity in the coefficients, but there is positive autocorrelation in the coefficients, suggesting the equation may be underestimating the standard errors of the regression coefficients, and the precise F and T-scores therefore are not strictly accurate.

The autocorrelation may be a result of misspecification of the model, and an additional variable, such as one separating San Francisco County or separating inner cities from suburbs would probably alleviate the autocorrelation in the residuals. Further work could probably resolve this issue.

CORRELATION MATRIX OF COEFFICIENTS
(Dependent Variable = CERES)

	ACCBHW	ACCNTW	DZBR	RDL70	CBDI
ACCBHW	1.00	.488	-.071	-.051	.180
ACCNTW		1.00	.089	.322	-.186
DZBR			1.00	.071	.181
RDL70				1.00	.189
CBDI					1.00

4. Percent change in employed residents. The equation predicting the percent change in employed residents is as follows:

$$\begin{array}{lll} \text{PCERES} & = & .087\text{ACCBHW} + .0009\text{DZBR} - 39.3\text{RDL70} + 4.21\text{CBDI} \\ \text{(t-statistic)} & & (2.17^*) \quad (.57) \quad (-6.07^*) \quad (2.47^*) \\ & & - .105\text{ACCNTW} + 37.54 \\ & & (-.40) \quad (7.50^*) \end{array} \qquad \text{(D-4)}$$

where PCERES = percent change in zone employed residents, 1970-75, and the same set of independent variables used in equation D-1

and $n = 239$

$R^2 = .17$ Durbin-Watson Statistic = 1.45

$F_{(5,233)} = 9.73^*$

*Asterisk indicates significance at the .95 coefficient level.

Significant coefficients were the same as the equation on percent change in population. Again, there appears to be positive autocorrelation in the error term, but no significant sign of multicollinearity. The autocorrelation again suggests a geographic bias in the error term, and an additional independent variable might eliminate that.

CORRELATION MATRIX OF COEFFICIENTS
(Dependent Variable = PCERES)

	ACCBHW	ACCNTW	DZBR	RDL70	CBDI
ACCBHW	1.00	.488	0*	.051	.180
ACCNTW		1.00	.098	.322	-.187
DZBR			1.00	.071	.181
RDL70				1.00	.189
CBDI					1.00

*Number is 0 in var-cov matrix, probably due to too few spaces allotted in program.

5. Retail trade employment. The equation for the change in retail trade employment between 1970 and 1975 is as follows:

$$\begin{array}{lcl} \text{CRETT} & = & -.641\text{ACCBHW} - .0046\text{DZBE} - 38.41\text{RDL70} + 237.7\text{CBDI} \\ \text{(t-statistic)} & & (-2.92^*) \quad (-3.88^*) \quad (-1.08) \quad (22.2^*) \\ & & + 2.10\text{ACCNTW} - 21.8 \\ & & (1.48) \quad (-.80) \end{array} \qquad \text{(D-5)}$$

where CRETT = change in zonal retail trade employment, 1970-75, and the same set of independent variables used in equation D-1, except for the substitution of DZBE for DZBR, with DZBE = BART influence (inverse of distance to closest BART station multiplied by 1976 PM peak hour station entrances)

and $n = 239$

$R^2 = .72$ Durbin-Watson Statistic = 1.63

$F_{(5,233)} = 117.95^*$

*Asterisk indicates significance at the .95 coefficient level.

CBD is the dominant influence in this equation, being primarily responsible for the "goodness of fit" of this equation. The BART influence and highway influence are both significant, but with negative signs. Analysis of the zonal change indicates that some of the largest increases are in CBDs with BART stations nearby, as in San Francisco and Walnut Creek. The BART term seems to be related to CBD, and in fact, the correlation matrix shows a fairly high degree of positive multicollinearity between these two variables. This suggests that the effect of the CBD and the BART effect cannot really be separated, and must therefore be evaluated jointly.

CORRELATION MATRIX OF COEFFICIENTS
(Dependent Variable = CRETT)

	ACCBHW	ACCNTW	DZBE	RDL70	CBDI
ACCBHW	1.00	.485	.077	-.067	.101
ACCNTW		1.00	-.024	.330	-.137
DZBE			1.00	.136	.526**
RDL70				1.00	.102
CBDI					1.00

**Significant multicollinearity.

6. Percent change in retail trade. The equation for the percent of change in retail trade employment is as follows:

$$\begin{array}{lll} \text{PCRETT} & = & -.0076\text{ACCBHW} - .00014\ \text{DZBE} - 1.15\text{RDL70} + 4.39\text{CBDI} \\ \text{(t-statistic)} & & (-.86) \qquad (-2.86^*) \qquad (-.80) \qquad (10.15^*) \\ & & + .0098\text{ACCNTW} + 5.80 \\ & & (.170) \qquad (5.24^*) \end{array} \tag{D-6}$$

where PCRETT = percent change in retail trade employment, and the same set of independent variables used for equation D-5

and $n = 239$

$R^2 = .33$ Durbin-Watson Statistic = 1.46

$F_{(5,233)} = 22.82^*$

*Asterisk indicates significance at the .95 coefficient level.

The CBD influence and the constant are the most significant terms in this equation. The BART influence is again significant and negative. In this case, the CBD and BART variables do not appear multicollinear. Some of the largest percentage increases in retail trade employment were in CBD zones near San Francisco and Oakland downtown BART stations. Therefore, although statistically significant, the effect of BART on the absolute level of the dependent variable is slight.

CORRELATION MATRIX OF COEFFICIENTS
(Dependent Variable = PCRETT)

	ACCBHW	ACCNTW	DZBE	RDL70	CBDI
ACCBHW	1.00	.476	0*	-.067	.100
ACCNTW		1.00	0*	.330	-.137
DZBE			1.00	.145	.003
RDL70				1.00	.102
CBDI					1.00

*Number is 0 in var-cov matrix, probably due to too few spaces allotted in program.

7. Business services employment. The equation for change in business services employment (primarily medical and legal services) is as follows:

$$\begin{array}{lll} \text{CBUSS} & = & -.96\text{ACCBHW} - .0019\text{DZBE} - 83.7\text{RDL70} + 346.2\text{CBDI} \\ \text{(t-statistic)} & & (-2.74^*) \quad (-.97) \quad (-1.46) \quad (20.0^*) \\ & & + 5.34\text{ACCNTW} - 73.5 \\ & & (2.33^*) \quad (1.66) \end{array} \qquad \text{(D-7)}$$

where CBUSS = change in business services employment, 1970-75, and the independent variable set used in equation D-5

$n = 239$

$R^2 = .70$ Durbin-Watson Statistic = 1.985

$F_{(5,233)} = 107.81^*$

*Asterisk indicates significance at the .95 coefficient level.

The BART influence is not significant in this regression, while the CBD, transit, and highway influences are. It is interesting that the highway impact is apparently negative, while the CBD and transit influences are positive. The coefficient of the BART term is highly correlated with the coefficient of the CBD influence, suggesting multicollinearity which may have accounted for the nonsignificance of the BART coefficient. Thus, despite the statistical test indicating nonsignificance, the BART variable cannot be dropped from the model.

CORRELATION MATRIX OF COEFFICIENTS
(Dependent Variable = CBUSS)

	ACCBHW	ACCNTW	DZBE	RDL70	CBDI
ACCBHW	1.00	.485	.089	-.067	.101
ACCNTW		1.00	-.021	.330	-.137
DZBE			1.00	.136	.526**
RDL70				1.00	-.102
CBDI					1.00

**Significant multicollinearity.

8. Percent change in business services employment. The regression equation for this dependent variable is as follows:

$$\begin{array}{lcl} \text{PCBUSS} & = & -.078\text{ACCBHW} + .00012\ \text{DZBE} - 9.60\text{RDL70} + 18.68\text{CBDI} \\ \text{(t-statistic)} & & (-2.92^*) \qquad (.83) \qquad (-2.22^*) \qquad (14.3^*) \\ & & + .401\text{ACCNTW} + 5.45 \\ & & (2.32^*) \qquad (1.64) \end{array} \tag{D-8}$$

where PCBUSS = percent change in zonal business services employment, 1970-75, and the same independent variables as in equation D-5

and $n = 239$

$R^2 = .56$ Durbin-Watson Statistic = 2.16

$F_{(5,233)} = 60.86^*$

*Asterisk indicates significance at the .95 coefficient level.

Similarly to the regression equation for CBUSS (the CBD, highway, and transit influences are significant, and the availability of land also is significant for the percent change equation), the above estimated model suggests that employment in business services has increased fastest in those fringe suburban areas that had large proportions of developable land in 1970. Again, the BART influence is not significant, but is highly correlated with the CBD influence coefficient, and the previous discussion applies.

CORRELATION MATRIX OF COEFFICIENTS
(Dependent Variable = PCBUSS)

	ACCBHW	ACCNTW	DZBE	RDL70	CBDI
ACCBHW	1.00	.486	0*	-.067	.101
ACCNTW		1.00	0*	.330	-.137
DZBE			1.00	.144	.531**
RDL70				1.00	.102
CBDI					1.00

**Significant multicollinearity.

9. Retail service employment. The regression equation for change in retail service employment is as follows:

$$\begin{array}{lllll} \text{CRETS} = & -.129\text{ACCBHW} - .0010\text{DZBE} + .619\text{RDL70} + 44.84\text{CBDI} & & & \\ \text{(t-statistic)} & (-2.70^*) \quad (-3.94^*) \quad (.079) \quad (19.0^*) & & & \end{array} \qquad \text{(D-9)}$$

$$+ .542\text{ACCNTW} - 3.17$$
$$(1.73^*) \quad (-.53)$$

where CRETS = change in retail service employment, 1970-75, and the dependent variables used in equation D-5.

and $n = 239$

$R^2 = .65$ Durbin-Watson Statistic = 1.59

$F_{(5,233)} = 85.31^*$

*Asterisk indicates significance at the .95 coefficient level.

The CBD influence is the most significant variable, followed by the BART influence (negative), the highway influence (negative), and the transit factor (positive). Although the BART effect is negative, the model correctly shows large increases in retail service employment in downtown San Francisco and Oakland; thus other factors have more than overcome the possibly negative impact of BART on CRETS. There is no indication of multicollinearity having influenced this result. Autocorrelation, however, makes the statistical tests and indications of stability less certain and caution in interpretation and application is suggested.

CORRELATION MATRIX FOR COEFFICIENTS
(Dependent Variable = CRETS)

	ACCBHW	ACCNTW	DZBE	RDL70	CBDI
ACCBHW	1.00	-.485	0*	.067	-.101
ACCNTW		1.00	0*	-.330	-.137
DZBE			1.00	-.137	-.00
RDL70				1.00	-.102
CBDI					1.00

*Number is 0 in var-cov matrix, probably due to too few spaces allotted in the program.

10. Percent change in retail service employment. The regression equation for the percent change in this category is as follows:

$$\begin{array}{lcl} \text{PCRETS} & = & -.014\text{ACCBHW} + .00044\text{DZBE} + 1.18\text{RDL70} + 1.80\text{CBDI} \\ \text{(t-statistic)} & & (-.86) \qquad (4.80^*) \qquad (.43) \qquad (2.19^*) \\ & & + .022\text{ACCNTW} + 2.92 \\ & & (2.06) \qquad (1.39) \end{array} \qquad \text{(D-10)}$$

where PCRETS = percent change in zonal retail service employment, 1970-75, and the same set of independent variables used in equations D-5 through D-9

and $n = 239$

$R^2 = .20$ Durbin-Watson Statistic = 2.30

$F_{(5,233)} = 11.83^*$

*Asterisk indicates significance at the .95 coefficient level.

The model for absolute change in retail service employment was a better "predictor" than this one appears to be. The CBD influence and the BART influence (positive in this equation) are the only significant variables for percent change, and there is multicollinearity between these two variables, as the correlation matrix below indicates.

CORRELATION MATRIX FOR COEFFICIENTS
(Dependent Variable = PCRETS)

	ACCBHW	ACCNTW	DZBE	RDL70	CBDI
ACCBHW	1.00	.485	0*	-.067	.101
ACCNTW		1.00	0*	.330	-.137
DZBE			1.00	.121	.535**
RDL70				1.00	.102
CBDI					1.00

*Number is 0 in var-cov matrix, probably due to too few spaces allotted in program.

**Significant multicollinearity.

11. Change in occupied dwelling units. The regression equation for the change in occupied housing units is as follows:

$$\begin{array}{lcl} \text{CODWU} & = & -.413\text{ACCBHW} + .126\text{DZBR} - 1121.6\text{RDL70} + 5.91\text{CBDI} \\ \text{(t-statistic)} & & (-.38) \qquad (2.97^*) \qquad (-6.35^*) \qquad (.128) \\ & & + 2.04\text{ACCNTW} + 1084.0 \\ & & (.287) \qquad (7.94^*) \end{array} \qquad \text{(D-11)}$$

where CODWU = zonal change in occupied dwelling units, 1970-75, and the set of independent variables defined in equation D-1 (AM BART influence)

and $n = 239$

$R^2 = .18$ Durbin-Watson Statistic = 1.76

$F_{(5,233)} = 10.19^*$

*Asterisk indicates significance at the .95 coefficient level.

The relative availability of developable land, the constant, and the BART residential influence are significant variables in this equation, and the sign of the BART influence is positive, suggesting a BART effect on residential construction patterns. The highway, transit, and CBD influences are not significant. There is no multicollinearity between coefficients and no autocorrelation.

CORRELATION MATRIX FOR COEFFICIENTS
(Dependent Variable = CODWU)

	ACCBHW	ACCNTW	DZBR	RDL70	CBDI
ACCBHW	1.00	.488	-.071	-.051	.180
ACCNTW		1.00	.089	.322	-.187
DZBR			1.00	.072	.181
RDL70				1.00	.188
CBDI					1.00

12. Percent change in occupied dwelling units. The equation for this regression is as follows:

$$\begin{array}{lll} \text{PCODWU} = -.0053\text{ACCBHW} + .0028\text{DZBR} - 56.07\text{RDL70} + .450\text{CBDI} & & \\ \text{(t-statistic)} \quad (-.153) \quad (2.08^*) \quad (-10.02^*) \quad (.306) & & \\ + .0474\text{ACCNTW} + 52.24 & & \\ (.210) \quad (12.07^*) & & \end{array} \qquad \text{(D-12)}$$

where PCODWU = percent change in occupied dwelling units, 1970-75, and the same set of independent variables used in equation D-1

and $n = 239$

$R^2 = .33$ Durbin-Watson Statistic = 1.67

$F_{(5,233)} = 23.01^*$

*Asterisk indicates significance at the .95 coefficient level.

The "explanation" level of the equation for the percent change in occupied dwelling units is somewhat higher than the equation for the net change, as is indicated by the R^2 and F statistics. The availability of land, the constant, and the BART influence are again significant and of the expected sign, with the availability of land being the key variable. Notably, neither the highway or transit influences are significant, but yet the BART term is. The BART influence shows no covariation with other terms, as the correlation matrix of coefficients indicates.

The significance of the BART residential influence for the change in dwelling unit models but not in the population models suggests that changing household composition and size makes population a less effective measure of household movement.

CORRELATION MATRIX FOR COEFFICIENTS
(Dependent Variable = PCODWU)

	ACCBHW	ACCNTW	DZBR	RDL70	CBDI
ACCBHW	1.00	.488	0*	-.058	.180
ACCNTW		1.00	.099	.322	-.184
DZBR			1.00	.074	.185
RDL70				1.00	.189
CBDI					1.00

*Number is 0 in var-cov matrix, probably due to too few spaces allotted in the program.